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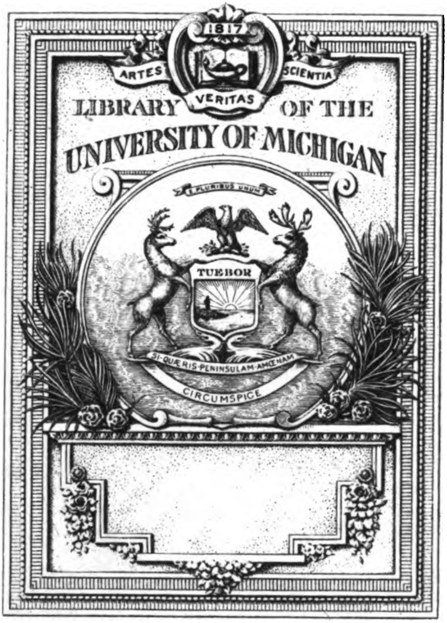

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THE

COMMERCIAL POWER

OF

GREAT BRITAIN.

VOL. I.

(10-173)

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THE
COMMERCIAL POWER
OF
GREAT BRITAIN;

EXHIBITING

A COMPLETE VIEW OF THE PUBLIC WORKS
OF THIS COUNTRY,

UNDER THE SEVERAL HEADS OF

STREETS, ROADS, CANALS, AQUEDUCTS, BRIDGES,
COASTS, AND MARITIME PORTS.

BY THE BARON Charles DUPIN,
MEMBER OF THE INSTITUTE OF FRANCE,
&c. &c. &c.

TRANSLATED FROM THE FRENCH.

IN TWO VOLUMES,
WITH
A QUARTO ATLAS OF PLANS, ELEVATIONS, &c.

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ADVERTISEMENT.

The enlightened and philosophical views displayed by the Baron Dupin in his Travels through Great Britain;—the great mass of official documents to which he has had access, and many of which he has, for the first time, reduced into a popular and comprehensive shape;—the peculiar opportunities of observation which have been afforded him, and the assistance which he has received from some of the most celebrated scientific men of the country;—all these circumstances have induced a belief that a Translation of his last work on the Commercial Power of Great Britain would be particularly acceptable. The subjects which are treated of in this production have, more than almost any others, occupied the attention of the Legislature and the Public for several years;—and an impulse has been given to the improvement of our Roads, Canals, Docks, and Harbours, which even since this recent publication of the Baron Dupin, are going forward with as much splendour and usefulness as the most magnificent works herein described. The Editor originally contemplated a supplementary notice of these new projects; but he found it so impossible to follow the course of these improvements in any thing like reasonable limits, that he declined the task, in the fear that he should be quite unable to emulate the accuracy and the extent of the Baron Dupin's researches and personal observations.

In the translation now offered to the public, a few passages of the original have been omitted;—the omission has been pointed out in the particular passages—and they are confined to one or two scientific details, not possessing a general interest in this country.

A considerable delay, for which the Publisher has to apologise, has taken place in the appearance of this work. It has been occasioned by the extreme labour required in rendering the French calculations of measure and value into English terms. A valuable service to the English reader has been rendered by this operation;—the difficulty of which can only be felt by those who particularly know how greatly a decimal system of notation varies from our ancient and less scientific method. The accuracy of the calculations in these volumes has been tried by several tests, and the Editor trusts that no very considerable error has escaped him.

June 15, 1825.

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INTRODUCTION*.

Δικαίου πολίτου, κρίνω τὴν τῶν πραγμάτων σωτηρίαν ἀντὶ τῆς ἐν τῷ λέγειν χάριτος αἱρεῖσθαι.

Ολυνθιακ. τρίτος. Δημοσθ †.

To analyze with regularity the elements of which the British Power is composed, we have first examined the institutions and the operations of the "Military Power," and of the "Naval Power." We have pointed out the means, offensive and defensive, of a country which nature has separated from the rest of the world, by the obstacles of the sea, and which nautical science has surrounded by ramparts hitherto impregnable; ramparts which serve also as means of attack; which convey armies from one hemisphere to another, and which, even on the most distant shores, meet with England still! England, equally prudent and ambitious, possesses on every continent, out-posts which, according to the fluctuations of her fortune, in turn give aid to her in conquest, and refuge in retreat; and which, at all times, are fields for the enterprise and activity of a commerce which braves every danger, and never allows itself to rest.

---

* Read at the general sitting of the Institute of France, June 2, 1823.

† I hold it to be the part of an upright citizen to prefer the advancement of the public good to the popularity procurable by the language of adulation.—Demosthenes, 3d Olynth.

Let us pause for a moment to contemplate this spectacle, unexampled in the history of nations. In Europe, the British Empire borders, at once, towards the north, upon Denmark, upon Germany, upon Holland, upon France; towards the south, upon Spain, upon Sicily, upon Italy, upon Western Turkey. It holds the keys of the Adriatic and the Mediterranean; it commands the mouth of the Black Sea, as well as of the Baltic. No sooner had its navy, the arbiter of the Archipelago, ceased to be adverse to the cause of Greece, than on the instant the ports of Peloponnesus found new liberators in the posterity of the Heraclides: and, from Corinth to Tenedos, the sea which leads to the Bosphorus, became to the descendants of the Argonauts the road to victory, and to a second and a richer golden fleece—National Independence! In Europe the British Empire permits this conquest.

In America it gives boundaries to Russia towards the Pole, and to the United States towards the temperate regions. Under the Torrid Zone it reigns in the midst of the Antilles, encircles the Gulf of Mexico, till, at last, it meets those new states, which it was the first to free from their dependence on their mother-country, to make them more surely dependent upon its own commercial industry:—and, at the same time, to scare, in either hemisphere, any mortal who might endeavour to snatch the heavenly fire of its genius, or the secret of its conquests, it holds, midway between Africa and America, and on the road which connects Europe with Asia, that rock to which it chained the Prometheus of the modern world.

In Africa, from the centre of that island devoted of yore, under the symbol of the cross, to the safety of every Christian flag,—the British Empire enforces from the Barbary States that respect which they pay to no other power. From the foot of the Pillars of

Hercules, it carries dread into the heart of the remotest provinces of Morocco. On the shores of the Atlantic it has built the forts of the Gold Coast and of the Lion's Mountain*. It is from thence that it strikes the prey which the Black furnish to the European races of men; and it is there that it attaches to the soil the freed-men whom it snatches from the trade in slaves. On the same continent, beyond the tropics, and at the point nearest to the Austral Pole, it has possessed itself of a shelter under the very Cape of Storms. Where the Spaniards and the Portuguese thought only of securing a port for their ships to touch at;—where the Dutch perceived no capabilities beyond those of a plantation,—it is now establishing the colony of a second British people; and, uniting English activity with Batavian patience, at this moment it is extending around the Cape the boundaries of a settlement which will increase in the South of Africa, to the size of those states which it has founded in the North of America. From this new focus of action and of conquest, it casts its eyes towards India; it discovers, it seizes, the stations of most importance to its commercial progress, and thus renders itself the exclusive ruler over the passes of Africa, from the east of another hemisphere.

---

* Sierra Leone.

Finally—As much dreaded in the Persian Gulf, and the Erythrean Sea, as in the Pacific Ocean and the Indian Archipelago,—the British Empire, the possessor of the finest countries of the East, beholds its factors reign over eighty millions of subjects. The conquests of its merchants in Asia begin where those of Alexander ceased, and where the Terminus of the Romans could never reach. At this moment, from the banks of the Indus to the frontiers of China—from the mouths of the Ganges to the mountains of Thibet; all acknowledge the sway of a mercantile company, shut up in a narrow street of the city of London!

Thus, from one centre, by the vigour of its institutions, and the advanced state of its civil and military arts, an island which, in the Oceanic Archipelago, would scarcely be ranked in the third class, makes the effects of its industry, and the weight of its power, to be felt in every extremity of the four divisions of the globe; while, at the same time, it is peopling and civilizing a *fifth*, which will follow its laws, will speak its language, and will adopt its manners with its trade, its arts, its cultivation, and its enlightenment.

This immense and wide-spread extent of colonies and provinces, which would cause the weakness and the ruin of any other nation, constitutes the safety and the power of the British people. It is because England is separated from her exterior provinces by enormous distances that she is not vulnerable through them: it is because these provinces are separated one from another by distances so great that they cannot at the same time fall under the blows of one adversary. To attack them is difficult; to blockade them is impossible. To supply the wants of industry, of trade, and of government, between the mother-country, and possessions scattered upon the shores of every sea, a vast number of ships is necessary, even in time of peace; and these ships ready to set sail at a moment's notice towards the threatened point, carry thither reinforcements and succour, which render it impregnable, either by famine or by force.

It is true that in any *one* of her distant provinces, England could not contend single-handed against its most powerful neighbours. But everywhere the most formidable nation is to the rest the object of envy, and of hatred hidden only by fear. Thus (if I may so speak) one of the most skilful branches of English industry, is the art to change into declared hostility the secret ill-will of surrounding nations. This is an additional interest which the capital of her commerce yields to her.

As for the nations which have no establishments on the frontiers of the English possessions, the sphere of their action is much more limited than that of her influence. No one of them could support a contest with Great Britain, on a field equally distant from both mother-countries; for no other nation has equal means to transport rapidly to a distance its arms and its defenders: such is the superiority of Commercial Power. One great example will place this truth (which is not yet sufficiently acknowledged) in a more striking point of view.

We see the Roman people stick to the earth like a persevering miner; advance by sapping, and from parallel to parallel, to take by degrees, all the military posts of the ancient world. It devotes eight hunded years to prosecute the siege of the universe. At last, insurmountable obstacles oppose a barrier to its invasions. Its aggressive force is shivered against Parthian flight and German resistance. It stops from very weariness before it reaches India.

The empire then rests as though oppressed with the burden of its greatness. Its defence needs more numerous armies than ever its conquests had needed. Nevertheless, these clouds of soldiers, scattered over an immense frontier, without means, without resources easy and quick of transport and concentration, find themselves everywhere isolated and weak. Warriors sufficing no longer, it became necessary to dig ditches and build walls, to shelter the empire of the Scipios and the Cæsars from being surprised by the barbarians. But such barriers are of strength, only through the armed men by whom they are defended. They never can stop the irruption of people, even the most ignorant of the art of war. The empire, pressed on all sides, decreases even more quickly than it had spread. It repasses the limits of each successive aggrandizement, even to its own entire downfall.

With a commercial and maritime industry, comparable to that of England, Rome, instead of making its offensive forces stationary, would have made even her defensive forces moveable. She would have carried them in time upon each threatened point, and would everywhere have shewn herself superior to the unconnected and intermitting aggressions of nations, strangers to the resources of civilization. The British empire, then, possesses in itself a principle of resistance which was wanting to the empire of the Romans. This principle is that of Commercial Power.

There was a time when to estimate according to its real greatness the power of a rival people, and to make that estimation known, would have displayed in the friend of our fellow-citizens the enemy of their glory, and the contemner of the superiority of a nation which wished to remain blinded. The flatterers of nations, as dangerous and corrupting as the parasites of kings, represented to the people of the continent, the dominion of the British Islands as having reached the brink of ruin, and declining at length from its zenith, at the very moment when it was digging the trench wherein to lay and to cover the foundations of a power entirely new.

In the eyes of a philosopher, the power of nations is a fact which he studies, as a naturalist studies a phenomenon, as a geometrician studies mathematic truths; to learn its principles, to discover its consequences. Such is the philosophy which ought to guide the traveller, if he wishes to give to what he relates the authority of history; or rather if he wishes to bring back history to its native origin, to replace it among the sciences of observation, and to render it what it was in the times of Herodotus and of Xenophon, of Polybius, and of Tacitus,—the science of the things and the places which we ourselves have seen*.

What portion of its prosperity the British empire, contemplated in this spirit, owes to Commercial Power, few words have sufficed to shew. But what means, what labours have produced that power itself? Could similar labours, could analogous means have raised other nations to the same degree of power? Can they do so still? This is what it behoves us to know: as Frenchmen, for the advantage of France; as friends of all humanity, by that just and generous sentiment which makes us feel interest in the dignity, the peace, the independence, the happiness of all nations, on whatever spot of the globe nature may have placed their country.

---

* καθ' ἱϛοριαν πλανηθῆναι: *Ad visenda loca, et mores hominum cognoscendos peragrare.* "To travel as an historian; to travel to see places and to become acquainted with the manners and morals of men." Such was the idea which Plutarch formed to himself of the real spirit in which we ought to travel.

Actuated by these great motives, we wish to learn the causes of the commercial prosperity of England. Let us beware of thinking we see them only in the deceptions of craft, and in the abuse of power.

The successes obtained in the government of the arts, are similar to the successes obtained in the government of men. We may succeed for a time, by fraud, by surprise, by violence; we can succeed permanently only by means directly opposite. It is not alone the courage, the intelligence, the activity of the manufacturer and the merchant which maintain the superiority of the productions and the commerce of their country; it is far more their wisdom, their economy, above all their probity. If ever, in the British Islands, the useful citizen should lose these virtues, we may be sure, that for England as well as for any other country, notwithstanding the protection of the most formidable navy, notwithstanding the foresight and activity of diplomacy the most extended, and of political science the most profound,—the vessels of a degenerate commerce, repulsed from every shore would speedily disappear from those seas whose surface they now cover with the treasures of the universe, bartered for the treasures of the industry of the three kingdoms.

It is necessary to penetrate farther into the knowledge of a national character to which the commerce of Britain owes its most astonishing successes. Let us contemplate this character, giving its own impulsion to the minds, as much as to the actions, of individuals; exciting an irresistible, insatiable ardour to surpass every rival, and above all to crush every foreign competitor, by a concurrence at once personal and national: and what means to accomplish such an end!—A cold, continuous, methodical activity, a calculated boldness, which makes the speculator risk every thing which the foresight, I might almost say, the divination of calculation, shews to him as having, on the whole, fewer chances of failure than of success. Add to these qualities, that perseverance in all undertakings, whether joint or individual, which partakes of the stability of their institutions; and whence springs in the long run, that constancy of character, and that number of energetic virtues which exercises upon the soul an action of which the mainspring is a public spirit inspired by the excellence of public order, and by the inviolable protection of laws proportionately beloved.

To these moral causes, we must yet add the rules both of political and domestic economy, which are favourable to all interests, stimulating to all branches of industry, encouraging to all descriptions of talent.

As to physical causes, we shall place at their head the public roads and establishments which facilitate the transport, and render safe the deposit, of merchandise, both in the interior and in the vicinity of the outports;—the art of this conveyance, and of barter and exchange;—and, lastly, the creation of those products of industry which are the subject matter of that barter and exchange.

We shall begin by describing the works executed with the intention to render, in every point of Great Britain, the communications necessary to internal commerce, rapid, easy, and of light expense; works which, so to speak, have drawn near to the coasts and outports, all the centres of production which industry has established within the bosom of the three kingdoms, at the same time that the progress and economy of navigation was drawing those kingdoms near to all the continents whither the British flag can reach.

After having followed the treasures of English industry to the sea-coast, through all those channels of interior communication, we shall trace its progress on board its ships and across the ocean. We will land with the mariners of England among every people which trades with her: we will examine that contest, apparently peaceful, which ever subsists between the commerce of England and that of other nations. Each people will offer to us the spectacle of a new species of combat; we shall see one raise itself to the race by its prudence and economy; another by the delicacy and good taste of its productions; a third by its boldness and activity.—We shall see them, for the most part, become inferior and be beaten, from having been unable to prosecute the contest with all these means united. Then we shall learn in how much the maritime and commercial greatness of the British Empire is fortuitous; and in how much it is foreseen, calculated, and necessary. We shall be able not only to reckon up the actual value of their sales, and of their territorial or mercantile acquisitions, but these data will also assist us to discover from the past the consequences which it may have upon the future. As a disciple of Archimedes learns to measure the durability of vessels according to his knowledge of their size and of their form, according to the action of their lading, of their sails, and of their rudders; so shall we learn to measure the stability of the British Power according to our knowledge of its physical resources and of its population; according to the combined action of its institutions and its laws.

The order which we shall adopt in inquiring into the commercial force of Great Britain, by beginning to inspect and to describe the works which foster and develop it, even in the centre of the state, to follow it by degrees even to the most distant shores; that order is the only one, the example of which is fitting to be offered to France. It is the interior which it is necessary first of all to vivify—to animate with an energy which can afterwards, without, enable us to hold our proper place upon every point of the globe whither our commercial industry will go to scatter its benefits.

This order, however, is the opposite to that which the English have followed in their efforts to possess themselves of the commerce of all nations. This we learn from their history.

At the commencement of the seventeenth century England scarcely possessed practicable roads; she had no canals; but the seas offered to her canals and roads, unbounded as were the hopes and the desires of England. In the British ports, art had, as yet, added nothing to the gifts of nature; and yet Queen Elizabeth already caused the universe to be explored by the conquerors of the grand Armada. Already the English had formed, under the auspices of their illustrious Queen, the East India Company, founded to prosecute a trade already known; and the Company of the North Seas, founded for the discovery and the acquisition of a trade of which they were as yet ignorant. In the same manner did the People-King, faithful to the worship of its ambition, erect in the Pantheon of conquered deities an altar to the unknown gods, that is to say, to the gods which they had yet to conquer.

The civil troubles which speedily followed after the reign of Elizabeth, were the means of carrying abroad, with a fresh ardour, the energy and activity of industrious citizens: And the lucrative acquisitions of external commerce were considered as the most fertile sources of both public and individual wealth, and as the element of the supremacy of the British people. Hence those stupendous efforts to rule upon the seas, and to acquire the preponderance upon the shores of every continent. But a power thus thrown so far beyond the territory which was to serve as its *fulcrum*, did not possess within itself the pledge of its durability and the guarantees of its prosperity:—it could lose by war that which it owed to war; and, by the maritime industry of rival powers, that which it owed to its own maritime industry.

One of those geniuses who seem born to place upon new foundations the destiny of empires,—a minister who would be without equal in his age, if he had had equal probity towards foreigners, with that which he had towards his fellow citizens,—Lord Chatham—undertook to transplant into the very soil of the country the roots of the external power of England: He determined to make the fortune of the citizens, and thence the fortune of the state, independent of the chances and the necessities of war. Always faithful in his engagements with individuals, he dared to make Credit a defence, or a weapon wherewith to fight;—he united individual force with public force, and the diplomacy of courts with the resources of the useful arts; so that he might attack, through every channel, the power and the wealth of rival nations. In a word, war itself, as well as peace, and treaties undertaken and prosecuted with an object purely industrious, had oratory for its means, conquest for its accessory, calculation for its ally, and commerce for its principal end.

In the hall where the mercantile bodies of the city of London hold their general meetings, I read upon the pedestal of a monument, erected by their gratitude to the memory of Chatham, the following inscription, which made upon me a profound impression:—

> "In grateful acknowledgment to the Supreme Disposer of events, who intending to advance this nation, for a time, to a high pitch of prosperity and glory, by commerce, for the first time, *united with and made to flourish by war*, was pleased to raise up as a principal instrument in this memorable work, WILLIAM PITT."

—It is necessary to point out the results of this astonishing conception.

It was under the administration of Lord Chatham, in the very midst of the seven-years' war, that we behold the commencement of all those great internal works useful to commerce, which are now the admiration of every foreigner. Up to 1756, England had not a single line of artificial navigation; she possessed, for communication by land, only a small number of roads, injudiciously cut, and ill kept up. Of a sudden, an individual conceives the idea to profit by the general impulsion which industry had received, by cutting a canal to carry to Manchester the product of his mines. Shortly afterwards a town which thrives, and of which the exuberant wealth seeks everywhere productive outlets—Liverpool—aspires to still higher designs;—she is the first to form and to realize the project of opening a navigable channel between the Irish Sea and the German Ocean. Other channels, even more extended, are established by degrees: thus, within the short space of half a century, a double row of canals is formed, both for great and for small navigation, for the purpose of uniting together opposite seas; basins separated by numberless chains of hills and mountains; opulent ports; industrious towns; fertile plains; and inexhaustible mines;—and this presents a development of more than 1000 leagues in length, upon a portion of territory not equal to one-fourth of France!

In order to distribute the water necessary for the daily life of the inhabitants, and the gas which produces a light so brilliant and so pure, that it seems, even in the darkest nights, to be almost an anticipation of dawn,—to fulfil this one object of general utility, pipes and conduits have been laid down, which even already form a ramification of above 400 leagues beneath the pavement of London.

The communications in the open air are

an object of equal solicitude, and of works even vaster still. The roads which already existed are enlarged; are reconstructed with more art, and kept up with more care. New channels are thrown open to commerce, and a system of roads is now being formed, of which the total length is at present more than 46,000 leagues in England alone.

While these prodigies are taking place, basins and ports are constructed for shipping. Moles, piers, light-houses, newly established, increase the security of access, and the shelter of every anchorage upon a line of more than 600 leagues of coast. Thanks to these works, at this moment, in the three kingdoms, 22,300 merchant vessels manned by 160,000 men, and capable of carrying two millions of tons of merchandise, are scarcely sufficient for the exportation of the superfluity of interior circulation; for the trade along the coast, and for the importation of those foreign products necessary to keep up a circulation so immense.

Such is the progress, the origin of which dates only from the seven years' war; a progress which the disastrous war against the colonies of America slackened, but could not interrupt; a progress, which on a sudden received new life, by the loss of these very colonies; a progress which, above all, has advanced with gigantic strides during the wars so bloody and so long of the republic, the consulate, and the empire of France.

It is thus that England was flourishing within, whilst her sacrifices, without, seemed to hasten her ruin and prepare her fall;—it is thus, that, even during peace, entering into a war of industry against all nations, animated by its internal commercial force, as a living being is by its vital force, she has overthrown all her rivals at the extremity of the new world, the same as in the heart of the old one. Once having gained the ascendency in this contest, she casts aside her ancient armour, and throws down the ramparts raised by her commercial prohibitions*. She opens her ports to foreigners, and offers them an entrepôt for their merchandise†. She asks only one favour of her rivals in industry, that is, to descend, unarmed like her, into the arena where her recent exploits render her certain of victory.

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* For the last three years, the British Parliament has been repealing, in succession, the most odious restrictions of the famous laws known under the name of the Navigation acts.

† By the law relating to entrepôts, London is destined to become the rendezvous of nations, and the mart of the universe.

What then has the British administration done to produce, in so short a time, public works which alone have rendered possible the great results of which we have been tracing the picture?—Nothing.—It has allowed commerce a free course, and has thought that it served it sufficiently in securing to it protection without, liberty within, and justice everywhere. It has allowed manufacturers, proprietors and merchants, of great, of moderate, and of small capitals, to confer with one another upon their mutual wants, upon the works which may be useful to them; and lastly, upon the means whereby themselves to undertake and to execute those works.

These works, which thus procure to commerce a new prosperity, had at the same time the advantage of adding to the value of landed property. To those territorial possessions which all human knowledge never will be able to extend beyond the boundaries which nature has given to them, it adds the possessions of industry, unlimited in their variety, their greatness, and their wealth, like the genius from which they spring. Thus, during the short interval of sixty years, commercial industry has created a property inseparable from the soil, to the extent of five hundred millions upon roads, of *a milliard* upon rivers and canals, and of another *milliard* upon the maritime ports and sea-coast*.

Gaining possession of these new acquisitions is not increasing in opulence alone. In becoming proprietors of canals, roads, bridges, basins, quays, and of the entrepôts necessary to commerce, citizens, at the same time, acquire the stable interest which is attached to the possession of immoveable goods, and the moveable interest which changes its objects or its seat, according to the arrangements and the vicissitudes of external commerce. Another benefit, also, is produced by these creations of industry. Whilst in England, ancient laws are favourable to the concentration of landed property, in too small a number of all-powerful hands,—there are other measures, which, full of wisdom, often put an end to this invasion of riches, by the property of combined capitalists:—a salutary check, established with a view to repair the deplorable losses which are experienced every day by the number of inhabitants who retain a part in the possession of the land of the country.

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* M. Dupin's estimations are, of course, here given in francs.—Tr.

In praising the happy division of property which commerce has produced, if we wish to remain within the limits pointed out by experience, and commanded by justice, we must not consider as entirely detrimental the concentration even of agricultural fortunes. Like most imperfect establishments, consolidated by long existence, the unequal distribution of territorial riches presents to us a mixture of good and evil, which, thanks to the caprice of mankind, and above all, to the miserable calculation of their individual interest, furnishes apologists even to the most revolting abuses, and detractors even from the changes which offer the happiest compensations.

In England, we must admit that the immense fortune of some individuals contributes powerfully to the undertaking, and to the execution of works of general utility, which demand from the companies united for such undertaking and execution considerable advances of capital, and long personal sacrifices.

The great proprietors are not the enemies of improvements and inventions propitious to industry and favourable to commerce. Far from envying the success of the working classes, they incline a whole people to industry, to foresight, and to economy; which, in giving to them ease and happiness, can render them independent and proud, as it becomes a rich and a free people to be*.

Often the great families of England, have themselves descended into the ranks of industry, to acquire new claims to popularity, to esteem, and to honours. It is thus they have been able to produce works of public utility, which seem to surpass the means and the sacrifices of private fortunes.

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* In the work which I have published, under the title "System of the British Administration in the year 1822," after having made known the admirable results of the Savings Banks, equally favoured by the working classes, by the opulent classes, and by the government, I add:—"Thus the British Ministry, in the account which it causes to be furnished of its acts, of its views, and of its thoughts, declares in the face of nations, that it places in the rank of benefits of public order and of social prosperity, not only the progress of the useful arts, and the activity of the manufactures, and the resources of commerce, and the happiness of the superior classes which direct those works; but also the development of the physical and moral independence of the inferior classes who execute those works. It delights in counting among its claims to glory the means of elevating, of exalting, the national character, in rendering more happy and less servile in all respects, the condition of even the humblest citizens; sentiments worthy of the ministry of a free people; sentiments which every man who attaches value to the dignity of the human species will honour with his homage; sentiments which deserve to be offered as models, to every government which wishes to walk in the path of national prosperity."

If you travel in the provinces and on the coasts of Great Britain, you will everywhere meet with the monuments of this magnanimous spirit. Would you know who were the creators of that canal which brings life and activity into the neighbourhood, and even into the heart of a great manufacturing town? It is a Duke of Bridgewater, who conceived and executed that fine enterprise. Who were the creators of that rail-road which carries a ten miles' distance the products of a mine, and the travellers of a country, to the shores of the sea, brought into an artificial port? And what powerful society constructed the plans, the basins, the moles, and the buildings of that port? It is a Duke of Portland, who, single-handed, was equal to these great works.

If you go through the finest cities of Great Britain, you will find, equally, at every step, monuments of public utility, raised by the single munificence of some opulent and generous individuals. A private merchant built the London Exchange; a knight constructed, at his own cost, the great aqueduct of the New River; a Cavendish, a Bedford, have created, on their own estates, in the finest quarters of the metropolis, squares as vast as the Place de Louis XV., streets as regular as the Rue de Castiglione, and even more spacious than the Rue de la Paix.

At the sight of these noble creations, you will, no doubt, ask to go to see the mansions and the palaces of these patricians, and plebeians with royal fortunes, to whom such great works are due. Well, when you have had pointed out to you the outside and the situations of the simple houses which they inhabit, in the heart of the capital, you will hardly be able to distinguish their dwelling from those by which they are surrounded.

Does not this striking contrast recal to our mind some traits of the eulogy pronounced by Demosthenes upon the celebrated men, whose works, whose virtues, and whose moderation shed so much splendour upon flourishing Athens?—

"Such were the men," says he, when recalling their military and political services, "such they were in relation to the general concerns of Greece. But in respect to this Athenian state in particular, judge for yourselves what their conduct was; as well in regard to the public interests as their own individually. For their public conduct—such and so many were the buildings and embellishments of temples which they erected, such the splendour of the offerings and the trophies which they dedicated, that no ground of pre-eminence has been left to any who succeeded them. In their private relations, so temperate were they, so perseveringly did they uphold the moral discipline of the state, that all of you who have any acquaintance with the condition of the houses of Aristides, of Miltiades, and their eminent contemporaries, must be aware that in point of splendour they were no ways distinguishable from those of their neighbours; for the state affairs were not then administered with a view to the personal objects of those in power; but each member of the admistration deemed it his individual business to promote the common welfare; and thus upon a system of fidelity to the universal interests of Greece—of piety to the Gods—and of equity at home,—they reared (as good reason it was they should) a splendid state of prosperity*."

Doubtless, so magnificent an eulogium, which belongs only to the finest times of an age altogether heroic, can only be but partly applied to the powerful men of Great Britain†; but, at least, it recals some of their virtues, and some of their efforts to add to the splendour, the riches, and the civilization of their country.

This fine character of the opulent and privileged classes; this enlightened patronage; this real patrician part—can we not hope to see it worthily filled among us? Ah! If the memory of the benefits bestowed upon society by the Bedfords and the Bridgewaters, the

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[*] Ἐπὶ μὲν δὴ τῶν Ἑλληνικῶν ἦσαν τοιοῦτοι· ἐν δὲ τοῖς κατὰ τὴν πόλιν αὐτὴν θεάσασθε ὁποῖοι, ἔν τε τοις κοινοῖς καὶ τοῖς ἰδίοις. Δημοσίᾳ μὲν τοίνυν οἰκοδομήματα καὶ κάλλη τοιαῦτα καὶ τοσαῦτα κατεσκεύασαν ἡμῖν ἱερῶν καὶ τῶν ἐν τούτοις ἀναθημάτων, ὥστε μηδενὶ των ὑπογιγνομένων ὑπερβολὴν λελεῖφθαι· ἰδίᾳ δ' οὕτω σώφρονες ἦσαν καὶ σφόδρα ἐν τῷ τῆς πολιτείας ἤθει μένοντες, ὥστε τὴν Ἀριστίδου, καὶ τὴν Μιλτιάδου, καὶ τῶν τότε λαμπρῶν οἰκίαν εἴ τις ἄρα οἶδεν ὑμῶν ὁποία ποτ' ἐστὶν, ὁρᾷ τῆς τοῦ γείτονος οὐδὲν σεμνοτέραν οὖσαν· οὐ γὰρ εἰς περιουσίαν αὐτοῖς ἐπράττετο τὰ τῆς πόλεως, ἀλλὰ τὸ κοινὸν αὔξειν ἕκαστος ᾤετο δεῖν. Ἐκ δὲ τοῦ τὰ μὲν Ἑλληνικὰ πιστῶς, τὰ δὲ πρὸς τοὺς θεοὺς εὐσεβῶς, τὰ δ' ἐν αὐτοῖς ἴσως διοικεῖν, μεγάλην εἰκότως ἐκτήσαντο εὐδαιμονίαν. Δημοσθ. ὀλυνθιακὸς ὁ τρίτος.—*Demosthenes' Third Olynth.*

[†] While we announce the fine actions and the great works of these powerful men, we shall not conceal, in the course of our work, the facts which diminish, in some respect, the glory of these titles.

Foxes and the Chathams, the Portlands and the Cavendishes, be always united with every idea of genius, of learning, and of eloquence; with every sentiment of patriotism and of loyalty; with every recollection of services rendered to the national industry, to the fortune of citizens, to the power of the state; have we not among us names equally illustrious to recal recollections of France and of the throne?

The names of Colbert and of Vauban, of Molé*, of Séguier†, of Malesherbes, and of d'Aguesseau; of Lauraguais, of Choiseul*, and of La Rochefoucault—all these names, do they not still live in the heart of France? The public works and the industry of the citizens, are they not still proud of their assistance? And the guarantees of our finest institutions, have they not for their supports the greater part of the families which these names adorn?—of families which recal to our gratitude those fathers of the people, and those props of the throne, who,—l'Hôpital in the council, Montausier at court, and Sully, both with the army and at the treasury,—consolidated the supreme authority by the directions of their superior genius, and by the tutelary resistance of their austere virtues? Assuredly, Yes!—We can never, for a single instant, withdraw from our memory names which, in the annals of our fame, are inseparably allied to the recollections of our greatest works, of all our monuments, and of the finest traits of our national character. It is by the example of these elder worthies that the career of our modern worthies must be traced; and this example can never remain barren in a land where honour is the first of goods, and the most noble of payments.

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* France has not forgotten that the finest public works of an era in which she erected so many admirable monuments in the heart of the country, as well as among foreign nations, had Molé for their director. If among the smallest works undertaken with an object of usefulness, we might be permitted to cite our travels in Great Britain, and this work which is its fruit, it would be a duty for us to say, in this place, that they found the most noble encouragement, at the time when the Comte Molé was at the head of the ministry of the Marine.

† It is a circumstance worthy of remark, to see at the present day, two brothers of this name; one who presides over justice, in the first Royal Court of France, and who, in his tribunal, will give nothing but judgments; the other, consul-general for our interests in England, and who, in this important post, will give only obligations; both to our country, to enrich it with every thing he observes useful in a nation which he knows thoroughly,—and to individuals, whether merchants or travellers of France. It is in this last capacity that I must express my gratitude to the Baron Seguier, for the communication of his information, his observation, and his manuscripts, upon the commerce and upon the administration of Great Britain.

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* It is not sufficiently known among us, that the magnificent roads cut from the capital to the principal points of our frontiers, were made for the most part under the administration of the Duc de Choiseul, one of the first statesmen of the eighteenth century; of that century, which, in the course of a single generation, displayed, in the persons of three other ministers, Turgot, Necker, and Malesherbes, as great a degree of talents and of virtues, as in administrations of the most brilliant eras of the monarchy.

By the side of the recollections which patrician greatness has left among us, let us recal with similar pride, for the fame of France, the beneficent works, and the patriotic undertakings of Jacques Cœur, of Riquet, of Laborde, of Beaujon, of Turgot, of Necker, and of so many other great men, who, wimning their glory at eras still more recent, have consecrated, by their labour, their morals, and their genius, the titles of their families, and the henceforth historical rank of their posterity.

But let us not content ourselves with seeking for our country instances of isolated glory, and of hereditary fame: let us extend our views, with equal favour, upon all classes of society; let us endeavour to spread a generous spirit of association, turned towards the undertaking of works useful to the state. Then we shall see bonds of common interest, of private friendship, of individual esteem, formed between all ranks, and in the midst of every party; and possibly public concord, together with the wealth and the power of the state, will be the consequence, less remote, perhaps, than we might at first sight hope, of the intercourse and the associations of which I am endeavouring to set forth, in their full light, the immense advantages.

This is no vain Utopia. In the country of which we are studying the prosperity, a grand and splendid experiment has shewn the power of those fortunate occupations to soften the bitterness of political passions, and to bring back internal peace by the agency of general well-doing. After the revolution of 1688, after the rebellion of 1745, what wounds were bleeding within every heart! What cruel recollections were festering in every soul! At this moment an useful diversion was created: Citizens of every class, united by a skilful government, to turn this concentrated ardour which burned within every mind, towards objects of general utility, made truce to their fatal discords. Whigs and Tories understood each other first, upon the improvement in the course of some river, upon the direction of some road, upon the formation of some harbour. Each party perceived, with astonishment, that it was not true that it alone had had in view the general good, the glory of the state, and the increase of the public wealth; each, it is true, retained the social attitude in which its character and its habits of thinking had contributed to place it; the one continued to serve their country under the majestic shadow of the prerogative, and the other by the lights of their popular virtues. But these rival citizens placing above all things love of their country, united in their hearts with loyalty to their king; such a sentiment became the source of a happy sympathy between every soul—toleration entered into political creeds, as it had previously entered into religious creeds; and the English, in a few years, freed from the humiliating situation of a vanquished people, not only abroad by French heroes*, but upon their own soil, by undisciplined mountaineers†, rises into the glorious state of a nation, dictating to the continent the laws of war and peace*. So great is the external preponderance of an empire which makes industry and commerce flourish, on the vivifying hearth of patriotism and concord.

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* At Fontenoy.

† M. Dupin here refers, it would seem, wholly to the period of the rebellion of 1745, and to the events of the war on the Conti-

If we invite our fellow-citizens to follow the path in which for half a century England has walked, for her happiness, and for her wealth,—let it not be supposed that we wish

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nent immediately preceding; but even with respect to this period he can scarcely be considered as strictly accurate. *Un people vaincu* is the expression in the original, which, to ordinary ears, would scarcely seem to be justified by the loss of two or three battles. I am aware, that among the never-ending niceties of the French language, *vaincu* is the most gentle expression which can be used to convey defeat; but, in this case it should be applied to the army in Flanders, and at Preston Pans, not to the British people, as a nation. With respect to Fontenoy we were certainly beaten right soundly; but we can scarcely be more justly termed, on that account, a vanquished people, than the French could be for their defeat at Dettingen, a very few years before; or at Minden, not many years after. The loss of a battle must every now and then occur to every nation in the course of a war; but it is not the more, on that account, a vanquished one. The strict application of the phrase would be found to have very humiliating effects upon almost every nation of modern Europe. As for the successes of the Highlanders, in the early part of their irruption in 1745, the speed and completeness of their defeat and suppression form a sufficient answer to the extraordinary idea of their being the vanquishers of the British people.—TRANSLATOR.

* If the English have, at present, fallen from this glory, it is from causes foreign from commerce, and of which I do not speak, for that reason.

by that to cause France to stoop to the subaltern part of an imitator. On the great interest which we are now considering, as upon every other interest, public or private, France, far from following, has given the example of what it is fitting and noble to undertake. Foreigners have been obliged to begin by imitating her, to be able to raise themselves to the same height; and if, sometimes, they have surpassed her, it is only when she has ceased to imitate herself. But, instead of praising our country with vain words, let us speak by facts.

The middle ages were still in a state of barbarism, when Charlemagne already taught to his age, that a canal cut between the neighbouring source of the Danube and of the Rhine, could unite the Euxine Sea with the ocean, and the north of Europe with the west of Asia. Henry IV. was the first among the moderns to proceed from conception to execution, and to unite, by a canal, waters separated by a chain of mountains. With the same genius with which he meditated the alliance of kings for the happiness of nations, he was contemplating the junction of seas for the prosperity of continents, when the knife of the assassin cut short the thread of those projects in which he was chalking out to Europe the true road to civilization and to social prosperity. Two generations of great men, under his son and his grand-son, were scarcely sufficient to realize even a small portion of his designs. The admirable works undertaken during his reign, to unite the Seine with the Loire, works interrupted for thirty years, after the fall of Sully, (that is to say, after the obsequies of his royal friend,)—Richelieu finishes. Richelieu displays to the European monarchies all the national advantage of yielding to the citizens the field, and the execution, of the interior channels of artificial navigation. Colbert, in the prosperity of a reign which owed to him so great a portion of its splendour, shews to the modern world, how it is possible to unite the ocean to the Mediterranean, by encouraging the zeal, and giving free scope to the genius of a private individual*; and the great Corneille immortalizes, in strains worthy of the Augustan age, the greatness of these works.

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* De Riquet, so well seconded by the experience and the talents of Andreossi.

Finally, Louis XIV., the legislator of these same works, ordains that a jury, composed of the most eminent inhabitants, shall decide, by a course of conciliatory arbitration, all the differences likely to arise concerning the property of this new public channel and the adjoining lands; and an hundred years afterwards, England, recognising in this the spirit of their laws, was proud to follow this example.

And we, my dear fellow-citizens, we who are French, shall we be less active in following the examples bequeathed to posterity by the great reigns of Henri Quatre and of Louis XIV.? Shall we allow foreigners to profit more than ourselves by the plagiarism of a prosperity invented by our own ancestors? Shall we not again possess ourselves of one of the palms of our hereditary glory?

We will again possess it. Already the successes obtained by some useful citizens authorize this hope. A single company has just completed with rapidity one of our finest public works; the greatest and the boldest of our bridges, thrown across the Gironde*, for the city of Bordeaux, the Liverpool of the South. Another company is about to unite, by a rail-road, the manufactories, the collieries, and the iron-works of St. Etienne with the banks of the Rhône, in the neighbourhood of Lyons; and thus open a communication worthy of our industry between the Birmingham and the Manchester of France*. At the gates of Paris, three companies have undertaken the formation of three canals, and others are being established with a similar view, in different parts of our territory.

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* The Gironde is the estuary formed by the confluence of

In contemplating these works so worthy of praise, ought we already to believe ourselves

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the Dordogne and the Garonne, as the Humber is by that of the Ouse and the Trent. Bordeaux, however, is on the Garonne, eight or ten miles above this confluence; and it is across this latter river that the celebrated bridge of which M. Dupin speaks is thrown. The Gironde, properly so called, is at least two English miles across in its narrowest width. The bridge of the Bastide, however, at Bordeaux, is, in every respect a magnificent work; and was, I believe, completed in much less time than was originally expected.—TRANSLATOR.

* St. Etienne is the seat of the chief collieries in France; it is about five and thirty miles south-west of Lyons, and probably eighteen from the nearest point of the Rhône. The general want of (at least worked) coal-mines in France will in all likelihood retard the progress of manufacturing skill, as the abundance of fuel in England has so strongly contributed to the development of our own.—TRANSLATOR.

to be near the goal of our efforts? Let us judge by the state of advancement of our rivals. We are going to have about five leagues of rail-road, and our rivals have five hundred. We are about to have ten or fifteen companies for artificial navigation; our rivals have an hundred. With us, government is still obliged to execute, at greater cost, and with less speed, works which individuals, uniting their means, might undertake with so much success, did they but possess this noble ambition*.

Certainly, it is from the bottom of our hearts, that we yield in common with all France, thanks to the government, when it supplies, as far as its isolated efforts can supply, the want of the spirit of enterprise, of the industrious emulation which ought to animate the mass of citizens. But it would be a still greater service to encourage, to excite within their souls, that productive spirit, and that general emulation, that combination and that harmony of individual efforts, which at once change the face of an immense territory, in causing everywhere to spring up the prodigies of art and of civilization.

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* The idea, at present in consideration, of establishing a general line of rail-roads throughout Great Britain, will, probably, in a few years, cause a considerable addition to the public works of a commercial nature, to which M. Dupin gives such just praise. It is, indeed, not one of the least extraordinary parts of this stupendous subject, to consider the extreme rapidity of scientific improvement and application; which thus will, probably, in a year or two, render even so recent and extensive a work as the present, comparatively imperfect and obsolete. The application of steam to the purposes of machinery may be almost considered to be as great a revolution in the arts of life, as the invention of gunpowder and of printing. May it not be said to unite the physical knowledge and practical utility of the one, with the civilizing and wide-spreading effects of the other?—TRANSLATOR.

Oh! my countrymen, it is in the name of glory, so dear to all magnanimous hearts, that France herself calls you to this new contest, where illustrious and beneficent victories await you! Formerly, in the time of just defences, we quelled aggressive nations, and for an immortal vengeance, continuing the work of the Pharaohs, the Cæsars, and the Kings, we have enriched the banks of the Nile, of the Tiber, and of the Rhine, by monuments devoted to the well-being of the vanquished. Let us surpass in our works for our country, our works for foreigners. Let us learn to be great, both by and for ourselves. Do not let us leave the labour of doing all for us to the hand which governs us. Let us have to compete with it, in skill, in vigour, and in perseverance, to triumph over the obstacles of nature, and to render them subservient to our social wants. These are conquests worthy of the most civilized of people, worthy of the ambition of the most enlightened among men: and we all can take a part in these conquests, according to the means, great or small, of our fortune or of our talents, so as to acquire a general and national honour; in the midst of which will arise reputations of which France herself will be proud.

In order to shew, by the precept of example, the immense advantages of a system of association, in which we are, as yet, only feeling our way with uncertain steps,—I do not fear to offer to your view the spectacle of an emulation which is equally serviceable to great nations and to illustrious men, in raising them above themselves, by the necessity of surpassing their rivals. Recal, then, in your minds, as a model worthy of you, noble children of France, that emulation entirely heroic, the source of the immortality of that great Athenian, whose genius was at once the honour and the safety of the very people whom you represent and revive, in its magnanimity as in its social charm; in amenity of manners, in atticism of wit, and in the love of glory. Unceasingly, O Themistocles! an internal voice troubled your sleep and deprived you of rest, in recalling to you the trophies of Miltiades, up to the instant in which you had surpassed him by still nobler triumphs! Oh! that my feeble voice could acquire that importunity to awaken and excite my country, as long as she shall not have surpassed all the works of her indefatigable rivál!

Let us beware of supposing, even for a single instant, that these victories are impossible to our perseverance. I have just proved, that as much as England is in advance of us now, so much, fifty years back, were we in advance of England; both in undertaking and in executing great works useful to industry and indispensable to commerce. What she has done in the course of half a century, we can do, more rapidly still. We can regain her rank, in profiting by her experience, as she profited by our's. Neither ardour nor activity, neither science nor genius, are wanting to our fortunate country. Our territory is more extensive, our climate is finer, our soil more fertile. An immense frontier, and two seas, open their outlets to the products of the bowels and of the surface of our earth; but we still need, to reach those limits, internal communications sufficiently numerous, sufficiently easy, and sufficiently cheap. Let us learn to undertake them, with the combined efforts, and the common sacrifices, of a large number of citizens. I repeat it again, for the last time; in devoting ourselves to these labours of association, we shall cement the alliance of all classes of the state, and of all the individuals of each class; and we shall advance, by the same step, to the aggrandizement of the physical force, to the confirmation of the moral power, of our country.

Let us endeavour to reach the end, before the termination of our career. The men of our generation, according to the ordinary course of human casualties, have yet some years to live. May Heaven grant, that at the end of their days, they may be able to say to the generation which will replace them—"We received from our fathers a France, impoverished, agitated, torn;—receive from us a France covered with monuments of public utility, erected by our labours; exuberant in wealth, the product of our industry;—more rich still in virtues, in concord, in magnanimity. Transmit to your descendants this inheritance,—aggrandized by you, as it has been by us; and may, from age to age, all the nations of the earth, enlightened by our knowledge, enriched by our industry, ameliorated by our examples, repeat for France that wish which a great man, when dying, breathed for his own country—*Esto perpetua!* May she be immortal!

THE

COMMERCIAL POWER

OF

GREAT BRITAIN.

THE
COMMERCIAL POWER
OF
GREAT BRITAIN.

PUBLIC WAYS,

BOOK I.—LAWS RELATIVE TO ROADS AND WAYS.

CHAPTER I.—*Of Streets and Throughfares in the Interior of Towns.*

WE shall devote this chapter to the legislative measures adopted for ensuring by regulations and establishments, health, safety, convenience, and freedom of communication in the interior of the towns of Great Britain.

As soon as one of these towns becomes sufficiently opulent to defray the expenses of a regular system of paving, application is made to Parliament for a law to regulate the details of this important branch of public service. Permission is granted, 1st, for the town to tax itself to defray the expenses of paving, lighting, *&c.;* 2dly, for the election of commissioners to collect and employ the funds destined for these purposes, as well as to preserve order in all that concerns the streets and thoroughfares.

In 1817, an act of parliament was passed (57th Geo. III., ch. 29), which comprised all the various measures previously adopted, and the efficacy of which had been proved by experience. This act now determines the regulations of the streets in the Capital of the British Empire. If we carefully examine the principal provisions and the spirit of this act, it will be found to suggest many important improvements with respect to the convenience, safety, and cleanliness of the streets and roads.

The officers appointed by the Lord Mayor and Aldermen to secure these valuable advantages to the inhabitants of London, are known by the title of *Commissioners of Paving* and *Commissioners of Sewers**. Both, however, form frequently one and the same commission.

Parliament having authorized the collection of the funds necessary for defraying the expense of paving, the commissioners levy on every house and shop, and all places destined for the habitation of men or animals, a tax* proportionate to the value of the building; which value is already officially determined by the amount of the poor-rates.

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* The power of appointing these commissioners is vested in the corporation of the city of London by the 19th C. II, c. 3, s. 22; but of course their authority is restricted within the limits of the city; which forms a small part only of the metropolis. Westminster, and the numerous other parishes within the bills of mortality, over the whole of which the 57th Geo. III. extends, are under the jurisdiction of local commissioners, trustees, vestries, and other authorities invested with the superintendence of the pavements, sewers, *&c.* The Act was intended to explain the duties and enlarge the powers of these functionaries.—*Translator*. S.

The legislature conceived that it would be unjust to require the inhabitants in the vicinity of any public building to defray the expenses of paving round that building. The commissioners of paving are consequently authorized to levy on the churches, hospitals, national schools, *&c.*, a tax proportionate to the superficies of the surrounding public thoroughfare †.

In some countries, far from contributing to defray the expense of keeping the roads and streets in proper condition, the officers of the church scruple not to obstruct and encroach upon the public thoroughfare. In Italy, and in other parts of Europe, I have always been astonished to see those monuments of religion which the traveller admires for the grandeur and beauty of their architecture, surrounded on all sides by wretched stalls and sheds fixed up against the external walls. Thus, for the sake of a paltry emolument, edifices whose dignity should exempt them from all contact with profane habitations, are vilely disfigured. The ancients knew better how to respect the structures which they devoted to their deities. The stalls of Rome, the shops of Athens, and the tabernæ of Memphis and Thebes, were not raised upon the very foundations of the temples of Minerva, Jupiter, Osiris, and Isis. In the promised land, the hand which drove away the "buyers and sellers" who presumed to profane the sanctuary, doubtless spared not the retailers of the peristile, or the stall-keepers of the portico.

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* Even the houses occupied by ambassadors are subject to this tax, which is paid by the owners. The landlord of an uninhabited house pays only one half of the tax. The commissioners of paving are authorized to reduce and even to remit the tax entirely to those individuals who plead poverty as the ground of their exemption from paying it. But those who refuse to pay the paving rate without assigning a valid excuse, are summoned before a justice of the peace.

† The tax amounts to one shilling for each square yard of foot carriage-way, and other pavements, over half the width of the street or public place round the edifice, or the areas or grounds in front of, or belonging thereto. This tax is paid by cathedrals churches, hospitals, and prisons, and by the proprietors of unoccupied grounds contiguous to the public road.

In England, it is the business of civil officers strictly to keep the exterior of churches free from nuisance. If the officers of a church, or the chapter of a cathedral, should encroach upon the streets or places surrounding a religious edifice, for the sake of letting any stall or tenement which they may have erected against the building, the municipal officers would, upon their own authority, remove all such nuisances, and fine the usurpers of the public thoroughfare.

It is also the duty of the municipal authority to see that the civil edifices, such as the houses of Parliament, the King's palace, *&c.*, are kept free from all encroachments of the kind above described.

In France, nothing but the storms of the revolution could succeed in extirpating, from the vicinity of our palaces, those excrescences of misery, which were so long favoured by the cupidity of inferior officers. But now that tranquillity prevails around these structures, we again see this parasite vegetation peeping forth on the spots where it formerly took root and spread without hinderance.

In England, regulations as effective are adopted for rendering the thoroughfares free, convenient, and safe in front of *private* houses, as around *public* buildings. No bulky article is suffered to be exposed on the outsides of shops; any stationary object obstructing the public path is equally obnoxious. They are liable to be seized by any surveyor or other person appointed by the commissioners of the pavements, or trustees; and the owner is subject to the penalty of 40*s*. for the first offence, and for the second and every subsequent offence, any sum not exceeding 5*l*. These measures denote the foresight of a people, who are fully aware of the importance of facility of communication, for the preservation of social order as well as for the prosperity of trade*.

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* We will here describe at length the legislative measures of which we have merely pointed out the general spirit. It is unlawful to place on the outsides of shops, and in the public thoroughfare, any stall, block, basket, cask, or any merchandise whatever; to suspend, place, or wash in the street, barrels or vessels of any kind; to leave standing in the public streets, trucks, wheelbar-

In passing along the most busy streets in the French capital, such as the Rue de Saint Denis, the Rue de Saint Martin, and the Rue des Lombards, which are considerably too narrow to admit of active traffic, it will be found that at least one third of their width is occupied by projecting stalls, by boxes and barrels placed on the outsides of the shops; and by waggons depositing their contents in the streets, instead of immediately conveying them into the warehouses, which would be both economical and easy. These details, which are so much neglected in France, can only be effectually regulated by a pow-

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rows, or vehicles of any description (except hackney coaches), longer than the time requisite for loading or unloading. Any one who transgresses these regulations may be summoned before a justice of the peace; and, on the testimony of one or several witnesses, he is fined from 2*l*. to 5*l*., which fine goes to the benefit of the funds for paving. The officers of the commissioners of paving (inspectors) are authorized to seize any object exhibited on the outsides of the shops, and any vehicles stopping unlawfully in the public thoroughfare. If, among the objects seized, there should be any of a nature that will not permit of their being kept, they are immediately forfeited and delivered to the overseers of the parish, or the governor of some prison situated in the parish. If, within five days after the seizure of preservable articles, the offenders do not reclaim them on payment of the fine, they are sold by auction, and the fine and the expenses being deducted from the produce of the sale, the surplus is paid to the owner. On a repetition of the offence, it is not necessary to wait for the decision of a justice of the peace. Any articles, vehicles, or animals, that may obstruct the public thoroughfare, are immediately seized and sold without delay, if the offender do not recover them on payment of the fines and expenses.

erfully-organized system of municipal police, like that which exists in England.

The care taken in the towns, and particularly in the metropolis of Great Britain, to render the public thoroughfares convenient to foot passengers, is particularly remarkable. It is an admirable fact, that in a country where the rich alone are the framers of the laws, the comforts of the poorer classes of the citizens are never forgotten in enactments, which, like these regulations, have regard to the public convenience.

Footpaths paved with large flag stones run along both sides of all the streets of ordinary width: even in the narrowest streets, the foot pavement is sufficiently wide to enable two persons to pass each other. Heavy fines are exacted from any individual who may drive a horse, a coach, a cart, or even a wheelbarrow, or roll boxes or casks on the foot pavement.

The following detail of the measures for securing *the safety* of public thoroughfares merits particular attention:—

The commissioners of paving fix up posts of wood, stone, or iron, along such parts of the foot pavements as they think necessary, and erect palings round unoccupied grounds, or dangerous places. Any damage committed upon these barriers subjects the offenders to a fine of from 2*l.* to 10*l.*, independently of the expense of repairs. In the principal streets there is in front of the houses an area, confined by an iron or wooden railing. From this area one may descend to the kitchen or cellar of the house, either by means of steps or a trap-door. If the entrance to the area be not kept carefully and securely shut, the householder is subject to a fine of from 2*l.* to 5*l.* If the owners of the houses refuse to keep the gates and trap-doors of their areas in good condition, the commissioners of paving may order them to be repaired at the expense of the offenders. The commissioners are authorized to remove penthouses, signs, and all projecting objects which may obstruct the public thoroughfare, or impede the free circulation of air and light. They are empowered to direct the course of the kennels in such a way as may be best calculated to ensure the cleanliness of the streets, and the convenience of passengers. It is unlawful to spread out or slake lime in the streets, except with the permission of the commissioners of paving, and in a spot enclosed by a barrier. As soon as any part of a street is unpaved for the purpose of making an excavation, posts and palings are fixed up, and lanterns and watchmen are stationed on the spot during the night, to prevent the occurrence of any accident to foot passengers, horses, carriages, *&c.* These precautions must be adopted within three hours after the communication made by the commissioners of paving to the companies who undertake the excavation, under pain of a fine of 5*l.* If, by the bursting of any drain, or pipe, the pavement sinks and becomes dangerous, the inspector of the pavement fixes up palings round the damaged part, until the repairs are completed. The expense is defrayed by the company whose works may have occasioned the damage.

We will next consider the regulations respecting *cleanliness*, on which the health of the community depends.

The sewers, which are constructed at the expense of the town, pass through the principal streets, and receive, by branch-pipes fixed at the expense of the owner of each house, all that can be carried off by water through these channels. The superintendence of the sewers is, in certain cases, intrusted to special commissioners[*]. See *Management of Water Conveyance*, Book II. chap. 1.

In England, it is unlawful to deposit any kind of filth, or even sweepings in the streets. They are kept within each house, and are removed, at least once every week, by the public contractors[†]. Thus the streets of the English towns nowhere present the disgusting aspect of the towns in the south of Europe, where dirt, and human and animal excrements, are thrown into the public streets, and consigned to the putrefaction which warm climates accelerate, and which gives rise to fatal endemic diseases.

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[*] The gratings which are placed over the drains, on a level with the pavement, are executed at the expense of this special commission, in conformity with directions and dimensions given by the paving commissioners. If the latter should think it necessary to construct new drains or gratings, they do so at their own expense; and afterwards consign them to the commissioners of sewers, whose business it is to keep them in order. Finally, whenever the commissioners of paving conceive that a cess-pool, a gutter, or a kennel running below or above ground, and communicating with the common sewer, stands in need of cleansing or repairing, they order the owner to execute what is necessary. If such repairs be not commenced and finished within three days, when such is practicable, according to the conditions laid down by the commissioners, the latter direct the work to be executed at the expense of the individual.

[†] For this purpose the commissioners of paving are empowered to contract, by bidding, with the scavengers and dustmen. Once every week the contractors are bound to send round their carts to remove the rubbish, ashes, dust, mud, *&c.*, collected in every house, under pain of forfeiting 40*s.* on every instance of neglect. Any householder who fails in the observance of this regulation is liable to be fined 5*l.* Where building or repairs are carrying on, the owner of the house must himself remove rubbish of every kind, within twenty-four hours after it is deposited in the street. If any individual, except those employed by the contractors, should remove the dust and dirt from the houses, his cart and horses are seized, and he is fined 10*l.* for the first offence, 15*l.* for the second, and 20*l.* for every succeeding one; one half of the fine goes to the informer, and the other half to the contractor. If the

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objects seized, and the property of the offender be not equivalent to the amount of the fine, he may be imprisoned, and sentenced to hard labour for thirty days. If the contractor suffer more than seven days to elapse without removing the dust from a house, the inhabitant, four-and-twenty hours after having given notice for its removal, has a right to sell the dust, and get it carried away by any one he may choose to employ for that purpose, before ten in the morning. Each householder is required to sweep the pavement before his door during frost and thaw, once every day, Sundays excepted, under pain of being fined 10*s*.

The nightmen are permitted to employ their carts only from midnight till five in the morning in summer, and till six in winter. The watchmen are ordered to seize all carts which may be found trangressing these regulations. An offender taken in the fact may be imprisoned for thirty days, and the person employing him thus unlawfully, may be sentenced to pay a fine of 5*l*. If the watchmen neglect to seize night-carts that may be found in the streets at prohibited hours, any individual is at liberty to do so, and the informer receives half the amount of the fine as his reward.

Carts which are employed in conveying oils, soap lees, ammoniacal liquid, mud, foul water, *&c.*, must have their sides raised up, so that nothing may be spilled in the streets by the jolting of the vehicle. The non-observance of this regulation subjects the owner of the cart to a penalty of 5*l*.

Any individual who beats a carpet, throws dirt, dust, *&c.*, into the street, kills animals in the public thoroughfare, or so near as to occasion their blood to run into the street, is liable to be amerced; and the informer receives one-half of the fine, which is from 2*l.* to 5*l.*, according to circumstances.

These disorders, though less dangerous in the climate of Great Britain, sometimes occasioned great ravages even in London, before the adoption of those regulations for cleanliness, which now render the British metropolis one of the capitals of Europe in which the average duration of human life is longest. In the populous towns of Ireland, on the contrary, and in those quarters of the towns of England and Scotland which are inhabited by the Irish, the lower classes of whom are horribly dirty, the typhus (which is analagous to the prison fever,) occasionally produces a mortality no less lasting and extensive than that which attends the plague at Constantinople. Even in the depth of winter the typhus fever is sometimes attended by the most fatal effects.

During the heat of summer, the copious watering of the streets, materially contributes to the preservation of the public health. Sometimes the streets are watered as in France, by carts, but more frequently by pipes which rise to the level of the pavement, and communicate with the subterraneous pipes by which the inhabitants are supplied with water*. Portable leathern tubes are affixed to the orifices of the branching pipes, and being terminated either by a spout or a rose, they are used to disperse the water over every part of the public thoroughfare.

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* It is the business of the commissioners of paving to superintend the watering of the streets. They are consequently empowered to contract with the manufacturers of pipes, the drivers of watering carts, &c.

The expense of watering is defrayed by the inhabitants of each street; but it is requisite that three-fourths of them should make an application to get the street watered. The tax levied for this purpose on all the inhabitants of the street must not exceed the fortieth part of the rent of the houses.

The advantages derived from an excellent system of street police would be of little importance, were not measures adopted for keeping the streets and thoroughfares in perfect repair. To effect this object, the law grants to householders a right of inspection *, and even of enforcement. The inspector

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* If a householder paying 50*l.* poor rates, or two householders each paying one half of that sum, conceive that any part of the street pavement is in such a state as to be dangerous to foot passengers or carriages, they are authorized to apply to get it repaired. The application must be addressed to the inspector, whose place of residence is described on a board, as we shall soon have occasion to notice.

The inspector immediately visits the places that may have been pointed out to him. If he should estimate that the necessary repairs would not cost more than 2*l.*, he must order them to be executed within three days after receiving the notification, and within seven days after it if the expense of the repairs would be from 2*l.* to 10*l.* If the repairs should exceed the cost of 10*l.* the inspector must address to the clerk of the commissioners a copy of the summons which he has received, in order that the clerk may call a general meeting of the commissioners. Two days are allowed for convening the meeting, and four days for holding it, making in all six days. If the meeting of commissioners acknowof paving is cited before the magistrates, if he refuse to conform to the legal demand made by one or several householders, for the immediate repair of the street, in places which are in such a state as to prevent secure and free traffic; he is fined if he be in the wrong; but if he can justify himself the fine is paid by his accuser.

Such is the salutary influence, such is the power of exercising judicial functions, which we should wish to see granted to every French citizen. It is not calculated to endanger supreme authority, while it is in the highest degree advantageous for the general prosperity and the welfare of the public. Let us hope to see this wish fulfilled.

The inspectors who have just been mentioned

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ledge the necessity of the repairs demanded, they must be executed in the twenty-eight days succeeding, if the expense do not exceed 50*l.*; and in forty-eight days if the expense exceed that sum.

If the repairs be not executed at the periods thus prescribed, reckoning from the day on which the application is made by the householders, they may summon the inspector before the justices of the peace, to account for his delay. If he cannot do this satisfactorily, or if he neglect to appear, he is condemned to defray the expenses of summoning and notices. He is then directed to execute the requisite repairs, and a period proportionate to the expense is again granted. If the application of the householders be not well founded, they pay a fine of 40*s.* to the inspector.

If the inspector exceed, without valid ground, the time granted by the justices of the peace for the requisite repairs, he must pay, for the benefit of the poor's rate of the parish, a fine not exceeding 10*l.*, 20*l.* or 30*l.*, for the first, second and third transgressions. *On the third, the inspector is deprived of his functions, and is declared incapable of discharging them at any time or in any parish.*

are the individuals who execute the repairs, *&c.*, of the public streets. They are paid either by an annual salary, or by a remuneration proportionate to the work performed. They may be dismissed at the will of the paving commissioners *.

As companies for the conveyance of gas are now being established in France, it will doubtless be interesting to know the regulations to which companies of the same kind are subject in England, with the view of preserving, in the utmost degree, the liberty, safety, and cleanliness of the public streets †.

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* The office of inspector can be filled only by a householder, or one who exercises some duties in the parish. He must not be a commissioner of paving, a paviour, a mason, a dealer in stone, or interested in any way in the contracts for paving. Every infraction of these regulations is punished by a fine of 20*l.*

As the inspector must have frequent official communication with the citizens, his name, christian names, and place of abode, are painted in large characters on a board, which is fixed up in one of the most public situations of the parish, of which he superintends the paving.

† These regulations are as follows:—The inspector must maintain continual communication with the gas and water companies. For this reason, within seven days after the nomination of the inspector, his appointment is notified by the secretary of the commissioners of paving to all the different companies whose pipes run through any of the streets of the parish to which the new inspector belongs. A similar notification is addressed to the commissioners of sewers, whose jurisdiction extends over the same parish.

A regulation dictated by the same motives enjoins that the secretaries, inspectors, and turn-cocks of the gas or water companies, shall within five days after their nomination make known their places of abode to the inspectors of paving, in the parishes inter-

We will now explain the functions of the commissioners of paving, as they relate to their labours and their responsibility.

sected by the water or gas pipes belonging to these companies, under pain of being fined 10*l.*

The gas and water companies must keep in their offices detailed plans of the course of their pipes. They must permit the commissioners and the inspector of paving, or their officers, to refer to their plans, and to take copies of them whenever such may be necessary.

The gas and water companies, and the commissioners of sewers, cannot take up any part of the pavement, except for the purpose of changing the direction of the pipes, and stop-cocks or plugs, or repairing them; substituting iron for wooden pipes, repairing or clearing the sewers, pipes, *&c.*, unless they give notice three days previously by a paper signed by their secretary, their inspector, or their turn-cock, and specifying the street and the particular spot to be unpaved. The commissioners of paving must then grant the required permission. Within twelve hours after the unpaving of the street commences, notice must be given to the inspector. If any one of these formalities be neglected, the offender must pay to the paving commissioners the sum of 40*s.* for every square foot of pavement which shall be so broken or taken up without such previous notice or consent.

Whenever an inspector of paving discovers that a pipe, a turncock, or any other part of the works belonging to the gas or water companies, or to the commissioners of sewers, is broken or damaged, he immediately forwards a written notification of the circumstance to the company. Within forty-eight hours after this notification, the company must unpave the spot pointed out, repair the damaged parts of their works, and cover in the pipes or sewers with good materials well cemented together. Within twelve hours after these works are finished, notice of their completion must be given to the inspector of paving. All these regulations must be observed under pain of fines.

It happens that pipes belonging to different companies run through one and the same street; if, therefore, the inspector should

When it is proposed to open new streets*, or to enlarge or improve old ones, the commissioners purchase, by private agreement, the ground requisite for the projected alterations or improvements. If they cannot come to an arrangement respecting the purchase with the owner, they convoke a special jury, (stat. 3, Geo. I., c. 25†.) The expenses of the valuation are defrayed by the party, public or

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mistake the company to which he supposed the damaged pipe to belong, the expenses of unpaving and digging are defrayed by the company whose works require repair.

The commissioners of paving are authorized to fix the period to be employed by the gas or water companies in the execution of any work, and the removal of the rubbish.

The companies merely confine themselves to laying down and working the earth over their pipes. It is the business of the paving contractor to replace the pavement, and the sand or gravel necessary for keeping the stones together. For the space of three months after this, the works which are occasionally found necessary in consequence of the removal of the earth, must be executed at the charge of the company, by whom the street was dug up.

If the necessary works for the repair of pipes are not executed, and the useless materials removed from the vicinity of the spot unpaved or dug up, within the prescribed period, by the companies who have undertaken them, the inspector of paving completes the works and removes the rubbish at the expense of the companies, who are moreover fined for their negligence.

* If the pavement in any new street is not laid down, or is in an unfinished state, the commissioners may, if they think fit, order the owners of the houses on either side of the street, to lay down the foot and horse pavement, over half the width of the public thoroughfare, fronting each house.

† The Act for the better regulation of juries.—*Translator*.

private, whose demands might happen to be the most remote from the estimates of the jury.

That the inhabitants may not be at once charged with too heavy a burden of taxes, the commissioners of paving are authorized to borrow the sums necessary for carrying on the works of the streets and public thoroughfares*. The current interest, and the gradual reimbursement of the loan, are charged upon the taxes levied for defraying the expenses of the works.

For the management and despatch of business, the commissioners of paving are required to hold a general meeting at least once every month; at these meetings all the contracts are concluded, after having been announced seven days previously in the public papers.

To form a meeting there must be at least five members present †. A new president is chosen at every meeting, and nothing is decided except by a majority of votes. Their measures and deliberations are registered in the minutes of the meetings, and are received as evidence in courts of law.

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* For this purpose the commissioners sign bonds of 100*l.*, bearing 5*l.* interest. Their treasurer sells these bonds to the highest bidder; they are transferable from one individual to another at the will of the purchaser, and are payable at the will of the commissioners.

Any individual upwards of thirty-five years of age may purchase a life annuity, secured on the paving funds. These life annuities are, like others, sold to the highest bidder. The sales are announced in the London Gazette a week before they take place

† In cases in which the law does not specify the number of commissioners requisite for the execution of any act, the presence of two is regarded as sufficient.

The commissioners are authorized to hire places for holding their meetings, establishing their offices, *&c.*, as well as an enclosure called the *Green Yard*, for the reception of all objects seized, in violating the regulations of the streets and thoroughfares. To this Green Yard are conveyed horses and cattle of every description found without drivers in the public streets, carts, coaches, *&c.*, and objects of every kind lawfully seized. The commissioners determine the ransom to be paid by the owners for the recovery of any property deposited in the Green Yard.

An individual obstructing the commissioners in the exercise of their functions, in any way whatever, incurs a penalty of 5*l.* for the first offence, 10*l.* for the second, and 20*l.* for every succeeding one.

The justices of the peace may compel witnesses of every description to appear before them, to give evidence in cases respecting the street regulations. The prosecutor, who gives evidence on oath, is considered as a witness. Any individual giving false testimony on oath, in these cases, is punishable for perjury. The commissioners and justices of the peace are authorized, in all instances, to give one half of the fine to the prosecutor.

Persons condemned by a justice of the peace may appeal to the quarter sessions; the expenses of the appeal are always defrayed by the party, public or private, condemned in the last instance.

The commissioners of paving appoint or dismiss their secretary at pleasure. It is the business of this secretary to institute, in the name of the commissioners, all prosecutions for offences against the street laws. The treasurer, collectors of taxes, *&c.*, are required to give a considerable security. If any of these individuals should receive the smallest bribe from a householder or a contractor, he is liable to a fine of 20*l.* Any officer of the commissioners who takes an interest direct or indirect in a paving contract, is dismissed from his situation, and becomes incapable of ever again discharging similar functions in the public service.

CHAPTER II.

Legislation of Open Roads.

The system of management relative to open roads, which has long been established in England, is, in many of its parts, a model worthy of imitation. This management, which is merely parochial, is in itself a complete government, exhibiting the representative, executive, and judicial powers, perfectly distinct from each other, in their attributes as well as in their operations.

In 1773 an act was passed in the British Parliament, which comprised within itself all the regulations established by previous statutes or by customs observed from time immemorial. This act, like most of the laws that have emanated from the same authority, is remarkable for the wisdom of its fundamental arrangements, and for the multiplicity of the precautions adopted to provide for every important case, to obviate, in the application of the law, all uncertainty, and consequently all arbitrary decision, and to remove every pretence for the hesitations and subterfuges, to which the most subtle and tortuous minds might be inclined to resort. But inexplicable defects materially detract from these valuable qualities which, in general, characterize the acts of the

British parliament. Incoherence and confusion prevail in the arrangement of the articles. Tedious prolixity* and endless repetition disfigure the noblest monuments of the wisdom and experience of a great legislative body. We will, however, endeavour to analyze, briefly, and in due order, the essential provisions of the laws relative to roads.

In England each parish forms the first political unit of the social aggregate. It has its own government; and provides for the maintenance of its poor, its church, and its roads. Every parish holds general meetings* composed of municipal officers, householders, and tenants paying taxes, to determine its local expenses, and to take cognizance of the conduct of its responsible officers. Every year ten candidates are chosen, from among whom the judicial power elects a surveyor of the roads of the parish†. This surveyor manages all the executive part of the business; the receipts, the expenditure, the works, all are under his control, and his personal responsibility.

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* The act relative to parish roads (13th Geo. III. chap. 78) would in itself alone occupy one hundred pages of this volume; and the act relative to turnpike roads (13th Geo. III. chap. 8,) would occupy upwards of sixty, if they were to be quoted literally. Since the passing of the two above-mentioned acts, upwards of twenty others have been introduced. The following is a list of the most remarkable:—13th Geo. III. ch. 78, 84.—14th Geo. III. chap. 14, 36, 57, 82.—16th Geo. III. ch. 39, 44.—17th Geo. III. ch. 16.—18th Geo. III ch. 28, 63.—21st Geo. III. ch. 20.—25th Geo. III. ch. 57.—34th Geo. III. ch. 74.—44th Geo. III. ch. 52. 55th Geo. III. ch. 68. I have carefully examined the articles of the subsequent acts, by which the provisions of the former ones have been modified or revoked (*a*).

(*a*) The list of statutes given by the author is by no means complete, though it may afford some idea of the extreme anxiety of the legislature to improve and preserve the public roads throughout the kingdom. The same zeal combined with more competent knowledge, has produced in the present reign two acts to explain, amend, and consolidate the general laws for regulating turnpike roads, *viz.*, the 3d Geo. IV., c. 126, and 4th Geo. IV., c. 95. These statutes are of great length, and contain the most ample provisions on the subject, with a nicety of detail which would seem calculated to meet every possible contingency. A similar act, (*viz.*, 4th Geo IV., c. 49,) has been passed for Scotland, so that the roads throughout the whole of Great Britain are now under a system of management, which being founded on many years experience, aided by vigilant inquiry and scientific research, must, if duly administered, insure to this country the most perfect roads in the world. *Translator.*

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* When a parish meeting is to be held, for the purpose of carrying into execution the measures prescribed by the road act, the day, the hour, and the place of the meeting must be published at least three days previously. The meeting is usually held within the bounds of the parish to which it relates.

† The formalities of election are thus prescribed by act of Parliament. The annual meeting for the nomination of the ten candidates for the situation of surveyor, is held on the 2d of September (*a*). The candidates must be inhabitants of the parish, possessing property or income to the annual amount of 100*l.* or occupiers of houses, lands, &c. of the yearly value of 30*l.* Three days after the meeting takes place, the constable or headborough of the parish transmits to one of the justices of the peace of the county, a duplicate of the list of the candidates. The original list is presented by the same officer at the special quarter sessions of the justices of the peace held in the first week of October. These justices of the peace then appoint one or more surveyor of roads for each parish, according to the peculiarities of the local situation. If ten persons cannot be found within the parish, to fulfil the required conditions,

(*a*) If this happens to be on a Sunday, the meeting is to be held on the Monday.—*Translator.*

The judicial municipal power, which consists of all the justices of the peace in the county, exercises a high and permanent inspection and authority over the management and police of the roads, and enforces the observance of the measures prescribed on this subject by the legislature.

When a justice of the peace meets with a case which he cannot of himself decide, he calls conjointly with one of his colleagues, a special session of justices of the peace, in order to deliberate on the means of carrying the law into effect, either by administrative or judicial measures, according to the nature of circumstances.

We will carefully examine the method adopted in the election of the surveyor of the roads, and the functions he has to perform. The surveyor of roads

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those who are best qualified are appointed, in order to complete the list of candidates. If the candidates presented do not appear capable of executing the duties allotted to them, the justices of the peace have a right to choose from among the most respectable house and lease holders of the parish who are not included in the list. On the death of a surveyor, the justices of the peace appoint another *ad interim*, until the period of the election comes round. In certain cases the law requires that the justices of the peace should appoint deputy surveyors, who are chosen from among the respectable inhabitants of the parish. They receive no salary, if they are chosen at once, but a salary is allowed them if they are chosen on the refusal of other persons. Any individual who declines the office is fined 50 shillings.

is, in England, analogous to the Ædile of the Romans. The office is gratuitous; its reward consists in the esteem and gratitude of the citizens. The law provides the means of exemption to the candidate chosen for the place of surveyor, if he can adduce valid reasons for not serving*. He who neglects to appear at the session of the justices of the peace, after the time of the elections, and he who within six days subsequently to his election neglects to make known whether he refuses or accepts the situation, subjects himself to a fine of *5l.*

That the same duties may not always devolve on the same individuals, one year's service as a surveyor is a ground of exemption from re-election for the space of three years.

When any one declines accepting the office of surveyor, the justices of the peace choose another to fill the place, and they may grant him a salary payable out of the fines and the rates collected for the maintenance of the roads †. If more than two thirds of the parish meeting agree to choose a professional man as surveyor of the roads, and vote to him a salary proportionate to his duties, then to the list of the ten gratuitous candidates is added the name of the candidate to be remunerated. If the justices of the peace prefer him to his competitors, he is appointed to the situation of surveyor, and he receives the salary offered by the parish. The justices can never grant a salary exceeding that offered by the inhabitants; for it is a natural and inalienable right of English citizens, to be taxed only by themselves, or by their representatives in Parliament. It is extremely important that this principle, which is essential to good parochial administration, should be adopted with us as an invariable rule, in all cases relating to the fixing of local expenses and granting salaries for municipal services. The same principle should likewise be extended in France, with an equal degree of precision to the pecuniary management of *communes des arrondissemens et des departements.*

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* According to the terms of the law, within the three days succeeding the nomination of the candidates by the parish meeting, the constable, &c. of the parish must give them notice that they have to appear at the special meeting of the justices of the peace, to accept the situation of surveyor, if they should be elected; or to make known their grounds of exemption, if they have any to bring forward.

† This salary must never be more than the eighth of a rate, which, in its total amount, must not exceed the fortieth part of the rental of the parish.

It will be seen that there are, in Great Britain, two distinct classes of road surveyors,—some exercising their functions gratuitously, and others with a salary. These latter are men better versed in the knowledge of the works they have to execute; and the parishes are entitled to exact more regular service from them. They are bound to provide a security, acknowledged by the justices of the peace to be sufficient, for the sums paid into their hands.

The voluntary surveyors are inspired with a consciousness of the honour which belongs to the fulfilment of the gratuitous functions assigned to them by the suffrage of their fellow-citizens, for the interest of the community. This feeling often dictates greater sacrifices, and prompts to more laborious and devoted exertions, than can be excited even by the attraction of a salary.

The works published in England relative to the construction and maintenance of roads, being written by professional surveyors, serve to shew the disadvantages of every kind arising out of the choice of gratuitous surveyors from the mass of the citizens. But we must not allow ourselves to be prejudiced by this circumstance. However, when the English do not find gratuitous surveyors, who combine intelligence with zeal and experience, I conceive they act wisely in appointing paid inspectors, who are well acquainted with every thing relating to the formation and preservation of the public roads.

We have the good fortune to possess that which is ardently wished for by all enlightened men in Great Britain; namely, a numerous corps of civil engineers, disseminated over every point of our territory,—a body of conscientious men, formed by superior study and experience.

It would be rendering a signal service to France, to derive from this important body all the advantages which their information qualifies them to afford. For this purpose it would be sufficient to identify the members of the corps of civil engineers with the local interests, and the municipal authority. I may be permitted to make, in anticipation, a few remarks on a subject so worthy the consideration of our legislators and statesmen. I do not pretend to lay down a perfect plan;—but to draw the attention of superior minds to this important object is at least rendering some service.

For the direction of the civil works of each *arrondissement*, consisting of one or two sub-prefectures, it would be requisite:

1st. That an accomptant should have the charge of the funds, keep the accounts of the receipts and expenses, superintend the financial part of the contracts, the payment of salaries, supplies, *&c.* This person, who should not be permitted to do any thing on his own responsibility, should act only in conformity with the *legal* and *always written* orders issued by the officer of the public works. The latter would thus be relieved from a multitude of tiresome details.

2ndly. An engineer should be exclusively intrusted with all civil works. He should enjoy the rank of our ordinary engineers of bridges and highways. He should be chosen from among the disposable officers of this rank, and from the candidates (*aspirants engénieurs*) declared to be eligible after a public examination * of their knowledge theoretical and practical acquired at the Polytechnic School, and at the school of bridges and highways.

I would suggest that the choice of the engineer of any particular arrondissement † should belong to respectable inhabitants of that arrondissement: for example, to citizens holding the rank of electors, or (if this class should not be sufficiently numerous) to citizens paying taxes to the amount of 200 francs, or only 100 francs.

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* The official report of these examinations should be printed and sent to the different arrondissements, to guide the choice of the electors.

† It is well known that France is now divided into 83 departments. Each department is sub-divided into four or five arrondissements.—*Translator.*

In order that the electors of arrondissements might make choice only of persons well qualified to discharge the duties allotted to them, they should be obliged to make their election from a list of twenty candidates, furnished by the directors-general of bridges and highways.

Every two or three years, the engineer should be subject to the examination of the electors of the arrondissement. He should have the right of retaining his place of residence, so long as he might not be opposed by *two thirds* of the votes. This would be a means of giving sufficient stability to his employment; and it would also serve continually to warn him, that if by weakness, unlawful compliance, incapacity, or neglect of duty, he should give dissatisfaction to the majority of the inhabitants, he would be officially sent out of the arrondissement; a disgrace which would render it very difficult for him to gain a situation in any other district.

In extensive arrondissements, and in those in which extraordinary works are necessary, the directors-general of bridges and highways should send some of the scholars of the Polytechnic School, on the list of *Aspirants*, who would thus be formed under the superintendence of men of skill.

The engineers of arrondissements should receive, for all communal roads, instructions from councils of arrondissements; for departmental roads, orders from councils of departments; and finally, for general roads, orders from the inspectors-general of roads and bridges. In these two last mentioned cases, the engineer-in-chief of the department should be the indispensable intermediary between the central authority, and the more ordinary engineers.

It would be requisite to maintain on the present footing, an engineer-in-chief for each department. To this superior officer should be added an accomptant-general of the public works, whose functions should be similar to those of the accomptants of each arrondissement.

The departmental engineers should be chosen from among the arrondissement engineers, out of lists of ten candidates, accompanied by testimonials of service, and presented by the directors-general of roads and bridges.

To the electoral colleges of the department should be consigned the choice of the engineer-in-chief of their particular department, and the ministry should reserve to itself the appointment of the inspector-general.

The bridge and canal companies should be free to choose, from all ranks, the most skilful and celebrated engineers who may correspond with their views, and may be willing to enter upon the duties proposed.

Thus persons interested in the good preservation and perfect support of public works of every description, would everywhere exercise immediate and continual influence over the engineers. They would ensure the zeal of these officers by exciting their emulation by the prospect of promotion grounded only on their merit.

The ministry might moreover possess the right of dismissing an engineer who should not fulfil his duties with due integrity, activity or intelligence; but this dismissal should not be arbitrary. It should only take place, when a jury composed, for example, of three engineers appointed by the state, three by the party assembled, and three citizens chosen by the arrondissement or department councils, should declare there is a just ground for the dismissal.

In the present state of things, an engineer may be distinguished for zeal, superior talent, great experience, and laudable activity, and yet nevertheless, if he have the misfortune to be out of favour with the central authority, he may drag out his whole life in an inferior situation. On the contrary, should he be ignorant, narrow-minded, indolent, negligent, and irregular, it is possible, if he take part in the prevailing opinions and passions of the day, that the time may come, when even the very extravagance of his conduct will ensure his triumph over his competitors who have nothing to recommend them save intelligence, industry, and modesty. These are evils which I would, under any circumstances, render absolutely impossible.

As to the salaries of the engineers, they should consist—1st, of a fixed *minimum* which would ensure to them a competency;—2dly, of an additional allowance proportionate to the extent and duration of the works in which they have to engage. By this means activity would be rewarded; and we should not see engineers perfectly unemployed, enjoying equal salaries with others who are burdened with occupation.

The richest arrondissements and departments, offering the most considerable allowances to the officers of the public works, would attract many of the most distinguished talent, and would invite them from one end of France to the other; without regard to the recommendations of offices, saloons, or ante-chambers.

I venture to affirm that great and important changes for the preservation and maintenance of public works would be the speedy consequence of the few innovations which I would propose to be introduced, with reference to the intelligent body of the engineers of roads and bridges.

Purchase and Alienation of the Ground over which Roads pass.

The ground occupied by roads belongs to the parishes whose business is to maintain them. As the ground thus employed is lost to cultivation, all display of pomp and grandeur in the useless width of the public roads is wisely avoided.

The roads in England were formerly much narrower than they now are. The limits of their width have been prescribed by Parliament, in proportion as the advancement of trade has increased the traffic maintained upon them.

Certainly the roads of Great Britain cannot be compared to ours in respect to width. But as they are kept in the best condition from one edge to the other, they afford perfect facility for the passage of carriages, *&c.*, at the sides as well as in the middle; thus they suffice for the most active traffic of horses and carriages. Foot passengers may also walk with ease and security by means of a foot path which is usually elevated on one side of the road.

When it is requisite to enlarge or change the direction of the public roads, the justices of the peace order the alterations to be made over the whole extent of the ground within their jurisdiction. However, the proposed alterations must not occasion the removal of any house, or encroach upon the ground within any enclosure, timber-yard, *&c.*

When it is legally determined to widen or to change the direction of any particular road, the surveyor of that road treats with the owners of the new ground over which the public thoroughfare, with its ditches, drains, *&c.*, is to pass. If the purchase cannot be satisfactorily agreed upon, a justice of the peace proceeds to the spots, and institutes all the necessary inquiries. On his report, the justices of the peace assembled at the special session, empannel a jury of twelve persons out of the list of the juries summoned for the session. This jury fixes the indemnity to be paid to the owner of the ground, taking into consideration the various local peculiarities, and the times and circumstances that may affect the value. The law prohibits the granting of an indemnity exceeding forty times the clear rental of the ground to be purchased. The sum determined by the jury* is offered to the owner of the ground. If he refuse to accept it, or if he be absent, the money is lodged in the hands of the clerk of the justice of the peace of the parish in which the ground in question may happen to be situated; from that moment the ground belongs to the state †, and becomes an integral part of the public thoroughfare.

If the estimate of the jury exceed that of the surveyor of the roads, the expense of valuation is paid out of the parish funds. If, on the contrary, the estimate of the jury do not go beyond that of

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[*] The sums for the purchase of this ground necessary for the improvement of a road, are raised by an assessment proportioned to the rent, which is levied on all the inhabitants paying taxes in the parish through which the road passes.

[†] By a curious reservation, even after this voluntary or forced cession of ground, the original proprietor is entitled to all minerals and fossils of whatever description, which may be dug out of those parts of the ground which he still possesses; and he has also the right of making excavations under the parts thus sold, without, however, damaging the road. All the vegetation that may happen to be upon the ground required for the public road, at the time of the sale, also belongs to the seller. If there happen to be any trees which the owner refuses to remove, the inspector orders them to be cut down, and laid along the side of the road.

the surveyor, the expense is defrayed by the owner who has refused to submit to the valuation. This is an excellent regulation. It renders appeals to the jury exceedingly rare; for the surveyor being checked by the fear of incurring a surcharge equal to the expense of valuation, and the owner being on the other hand checked by the risk of suffering a diminution of profit, equal to those expenses, both parties naturally refrain from inflexible obstinacy, and adopt a course of moderation which is mutually advantageous.

Happy is the country whose laws are so wisely ordered that they tend to prevent legal contests among the people!

If any owner of ground should conceive himself to be injured by the proceedings of a *special session* of the justices of the peace, he may appeal at the next *general session*, whose judgment is definitive.

In case of a road being carried into a new direction, wholly or in part, those portions of the old road which become useless are sold by the surveyor, with the approbation of the justices of the peace. The produce of this sale is devoted, according to the forms above explained, to the purchase of the ground that may be required in the new course of the road.

It is an invariable rule that an old part of any road cannot be alienated, unless two justices of the peace previously visit the new part, and certify that it is perfectly fit to supersede the old one. If the old and new parts of the road pass over the estate of one land-owner, he acquires the right of appropriating the ground occupied by the old part of the road, as a compensation for the ground he has furnished for the new part. When a local road is declared to be useless, the justices of the peace, exercising a jurisdiction over the parish in which the road is situated, may order it to be suppressed and sold.

It is strictly enjoined that no innovation can take place in the direction of roads, unless previous intimation be given to the individuals interested. The preliminary measures of publicity are prescribed by Act of Parliament [*]. These measures afford to the individuals who may be aggrieved by the innovations, every opportunity of asserting and enforcing their rights.

Road Labour.

This labour devolves on property, without regard to the privileges of individuals or classes. The nobility, clergy, and yeomanry, take part in it in equal proportions, according to the amount of their property or incomes.

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[*] See the act of the 55th Geo. III. c. 68. This act prescribes that in the projected suppression of any road or part of a road: 1st, that the announcement of such suppression shall be posted up on the spot over which the new road is to pass, and on the spot over which the part to be suppressed passes; 2dly, that a similar announcement shall be posted up on the doors of the church of the parish within which the projected alterations are to be made; 3dly, that the announcement shall appear in the public journals, circulated in the county, at least three times before definitive measures are adopted.

The law determines the number of days for the labour which may be annually required for the support of the public roads, and which can never be demanded for any other purpose. The surveyor of common parish roads cannot require more than six days' labour from the parish; and the surveyor of turnpike roads can demand only three.

Since the year 1794 *, the surveyor has been authorized to require that their statute labour shall be substituted by money, if such should be deemed most advantageous for the maintenance of the roads. The citizens also possess the right of substituting for labour an equivalent in money †. They may

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* A rate has been established for all parts of the kingdom. In 1814, the legislature considering that the value of the labour of men, horses, *&c.*, is not the same in different parts of England, abolished the general rate, the prices of which had been raised in 1804. The justices of the peace were then empowered to establish particular rates, according to the current prices of each district.

† If labour be required only from a portion of the inhabitants, lots are drawn separately, for the horses on the one part, and the labourers on the other. But if, in the succeeding year, the lots must be drawn again, the individuals who served during the preceeding year have the right of exemption (*a*). If any individual keep

(*a*) The act, in providing for the payment of money in lieu of statute duty, contemplates the possibility of such a sum being demanded of the parish for the hire of horses and labourers, as to render it expedient to demand that the statute duty or some part of it should be performed in kind, in which case the plan mentioned in the note may be adopted.—*Translator*.

thus exempt themselves from the road labour properly so called. This tax is the most just of all, since it applies to the immediate improvement of the ground occupied by the inhabitants who pay for it.

In order to render the road labour less burdensome to the agricultural classes, the law relieves them from this duty during three particular months of the year, which are determined in each parish by a general meeting of the inhabitants *; those intervals of exemption are the sowing, mowing, and harvest months.

We will now briefly explain the principal regulations laid down by the law in the establishment and execution of road labour.

Every individual possessing a plough or heavy carts, with three draught horses, or two horses and two oxen, or one horse and four oxen, must furnish these animals and two labourers for the road work †.

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plough horses, without carts, he must pay the inspector for every day's labour, a certain sum per horse, or he must pay according to the rental of the ground, at the pleasure of the inspector.

[*] It is only necessary that the surveyor of the roads which pass through the parish should receive notice a fortnight before any suspension of the statute labour.

[†] Persons who do not keep a team of three horses or an equal number of oxen, but only one or two draught animals with carts employed on the public roads, must furnish them for a period of labour equal to that supplied by the other taxed inhabitants, only with a man to drive each cart. Every individual who, without possessing a team, or land or houses to the amount of 50*l.* but

In case there should be a greater want of labourers than of horses, the individuals subject to the duty of road labour, must, on the requisition of the surveyor, send instead of each team, three men, fit to work, and furnished with the necessary tools; or they must pay the wages of the labourers during the days they are employed *.

Every inhabitant not less than eighteen or more than sixty years of age, who is neither an apprentice nor a servant, who is neither a land owner nor a tenant of property to the amount of 4*l.* sterling, nor the possessor of horses or carts subject to statute labour, is required by Act of Parliament to contribute personal labour, during the period in which the other inhabitants supply men and horses.

According to an Act passed in 1773, every individual who is, by the amount of his income, exempt from personal labour, and who nevertheless is not possessed of more than 50*l.* sterling, must pay the fortieth part of his income for six days of road labour. Persons possessing from 50*l.* to 100*l.* must pay double. This proportion having been found insufficient for the support of the roads that are most frequented, Parliament raised the tax to 1*s.* 9*d.* † in the pound on the income of the land owners (54 Geo. III. c. 109.) The same act, sect. 5, determines that every person bound to furnish road labour in money and not by sup-

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who may keep a post chaise, a carriage, a gig, *&c.*, must pay to the surveyor, during the days of road labour, a sum fixed by the justices of the peace for each of his horses, or he must pay in proportion to the value of his property, at the option of the surveyor.

* In 1773 the amount of these wages was 4*s.* 6*d.*

† Any person refusing or neglecting to contribute to the statute labour, is condemned to pay a sum amounting to double the value of that labour, according to the rate fixed by the justices of the peace.

plying men, horses, &c., must pay out of every pound of his income one-fiftieth part of the price fixed by the justices of the peace, for the daily hire of a cart with three horses, accompanied by two labourers *.

We will now describe the manner in which road labour is executed. The surveyor of the roads fixes, at least four days previously, the time and the place of the labour, which lasts eight hours per day. Individuals who fail in contributing to the statute labour are punishable by fines, which are employed in defraying the necessary expenses for the support of the roads. The surveyor may demand only a portion of the supply of men and horses, if he should deem it sufficient. If the drivers and labourers sent with carts and horses should not be able or willing to work as they ought, the surveyor may send them back again. The owner has then to pay the same fines as though he had refused to contribute to the road labour.

When the supply of carts, horses, &c., is insufficient for the conveyance of materials, so that it becomes necessary to pay for additional labour for the support of the roads, the surveyor must contract for this labour at a parish meeting, publicly convoked, ten days previously, by an advertisement, specifying the nature of the contracts to be concluded. Any surveyor who takes an interest direct or indirect in these contracts, is fined 10*l.*, and declared to be for ever incapable of being employed as a *fair* surveyor.

If the total amount of the supplies of men and horses, compensations in money, and fines, be not sufficient for the support of the parish roads, the justices of the peace may order a tax in money to be levied on the inhabitants. The sums collected by fines, *&c.*, applicable to the roads, must never be paid into the public treasury. They are lodged in the hands of the surveyor to be employed in paying for the works.

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* Land owners having a smaller income, but possessing a cart, or carriage, &c., with less than three horses, may be taxed, at the option of the surveyor, in proportion to their revenue, or in proportion to the number of horses they keep, according to a rate fixed by the justices of the peace, sect. 6, act 54 Geo. III, c. 109.

Measures relative to the support of the Public Roads.

Legislative regulations of a severity proportional to the nature of the offences, secure the prevention or punishment of any injury that may be committed upon the roads by the neighbouring land owners. It is highly important that this part of the British legislation should be made known in a country like France, where so little attention and regard is paid to the public roads, by the individuals in their vicinity.

The law punishes any encroachments that may be made, by digging a ditch, planting a hedge, or fixing up a pailing within at least 15 feet from the centre of the road. It is unlawful to dig, plough, or harrow the ground occupied by the public road within the prescribed limits *.

A private individual may indict for any injury committed to the public roads. The parishes in a body generally institute those prosecutions, in which they are powerfully interested, since the inhabitants of each parish have to defray the expense of maintaining the roads within their own boundaries *.

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* Any individual who may give information of an offence of this kind, receives the fine of 2*l.* which is exacted from the offender. Moreover, the expense incurred by the destruction of the hedges and palings, and the filling up of ditches, in short the repair of all damages, is chargeable on the offenders, 13 Geo. III. c. 78, sect. 63.

The law grants to every citizen a right of inspection over the works for keeping the public road in good condition. If any private individual justly accuse the persons intrusted with road works, of neglecting their duty, or not executing it in a satisfactory way, the justices of the peace are authorized to reward the accuser. On the contrary, if the accusation be frivolous or malignant, the accuser must pay damages to the accused. Thus the reward held out by the legislature, for encouraging private individuals to keep a watchful eye over the public interest, ensures the certainty that any palpable malversation or negligence will receive a check; while, on the other hand, the payment of a fine, and the disgrace attendant on accusation, publicly declared to be false and scandalous, prevent any wanton attacks upon the persons appointed to direct or execute the works for the maintenance of the public roads.

It is necessary to adopt special plans for drying the roads, in a country where they are made nar-

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* When the inhabitants of a parish assembled at a meeting, resolve to prosecute any one for offences of this kind, they authorize the surveyor of their roads to include in his accounts the expenses of the prosecution. The surveyor afterwards pays these expenses out of the funds that are lodged in his hands. 13 Geo. III. c. 78.

row, where the climate is extremely damp, and the heat of the sun seldom powerful. In England regulations are made for effecting this object. Trees and shrubs must never be planted within 15 feet of the centre of the road. If any such plantation should exist, and the trees, *&c.*, be not cut down within ten days after the order to that effect, given by the surveyor to the owner of the ground, the latter is subject to a penalty *; and if necessary, the judicial authority interferes to compel him to clear the public thoroughfare.

It is not enough that the hedges and trees should be planted within the specified distance from the centre of the road; they must also be cut so as not to occasion too much shade, and above all not prevent the free circulation of air, for drying the ground in wet weather and sweeping off the dust in dry weather †. A land-owner refusing, on the application of the surveyor to cut his hedge-rows, as the law requires, would be compelled to do so by the authority of the justices of the peace; he would moreover have to pay a penalty proportionate to the length of the road bordered by the hedges or trees not cut in conformity with the law.

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[*] Except the trees be for ornament or shelter to the house, &c., of the owner thereof.—*Translator.*

[†] The law specifies the particular months during which the land-owners are required to cut their trees and hedges, within the jurisdiction of the road surveyor.

The ditches and drains that run along each side of the road, and which are necessary for keeping it as dry as possible, are made and kept in repair by the owners of the adjoining ground. They must also defray the expense of making pipes and bridges in those parts where horse and foot paths branch off from the public road into their property. If they neglect to execute the necessary repairs, they are fined 10*s*. for each offence.

The surveyor has the right of examining, whenever he pleases, the roads, causeways, bridges, pavements, pipes, drains, hedges, ditches, *&c.*, through the whole extent of the parish to which he belongs. If he discover any depredation, obstruction, or innovation, contrary to the terms of the law, he requires the repairs or removals to be executed by the offenders, or by the persons who are bound to execute them. If within twenty days after this notification, all is not restored to perfect order, the surveyor directs the work to be executed at the expense of the offenders; the latter moreover pay a fine proportionate to the length of the hedges, drains, ditches, *&c.*, which have been repaired.

The law authorizes the surveyor to make new ditches and drains, or to enlarge the old ones in the grounds adjacent to the road, if such should be deemed necessary, for carrying off the water and keeping the public roads in good condition. Indemnities are granted to the owners of the grounds.

From time to time the surveyor must submit to the justices of the peace a complete plan of the situation of the roads, bridges, causeways, and pavements, which may happen to be out of order, and which must be repaired either by private individuals or by public bodies*. The justices determine the time necessary for these repairs. If they are not completed on the fixed day, the offenders are summoned to appear at the next session of the justices of the peace. These magistrates are authorized to execute the repairs at the expense of the offenders.

That the surveyor may not be influenced by the desire of favouring any particular friend, or securing any personal interest to himself, the justices of the peace are authorized to specify the arrangements to be adopted in the different works for the support and repair of the roads.

We will close this chapter by describing the legislative measures relative to the excavation, purchase, and transport of the materials to be employed in the road-work.

The surveyor may procure gravel, sand, chalk, or stone from the commons, and from every river and stream, throughout the

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[*] Art. XXIV. of the general act relative to roads, specifies how the road surveyors are to present at the general quarter session of the justices of the peace. 1st. The general list of the offences against the road statute. 2d. An estimate of the repairs to be made, either by the parish, or by individuals; so that the court may determine the amount of the fines to be exacted, and the taxes to be raised, for the purpose of restoring the roads and their accessaries to a perfect state of repair.

whole extent of the parish to which he belongs. But he is prohibited from turning any current of water, or from injuring by his excavations any private or public buildings. He must not dig within less than 100 feet above or below bridges, dams, *&c.*

If, in consequence of excavations made for public or private works, any damage be committed upon buildings, roads, bridges, fords, mines, *&c.*, the offender is compelled to pay a fine equivalent to from 20*s.* to 5*l.* (25 to 125 francs), in addition to a reasonable compensation.

Any individual suffering injury by the removal of the materials necessary for the road work, is indemnified by the surveyor*.

If the grounds which are parish property be not sufficient to provide materials for the road work within the parish, the surveyor at the general session of the justices of the peace, applies for permission to provide himself in the parish grounds and water courses of the adjoining parishes by paying an indemnity. This indemnity is settled between the surveyor and the owner of the property, in the presence of two or more respectable inhabitants of the parish. If the parties cannot come to an agreement, the matter is referred to the justices of the peace.

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* In order to collect stones on the ground of any private individual, it is requisite that his consent should be procured, or that a justice of the peace, after hearing his objections, should pronounce a special decision to that effect.

It is also requisite to obtain the consent of a land-owner to dig in his quarry. But the surveyor is authorized to collect, without any previous consent, from every quarry in his parish, the stones of which he may stand in need. The surveyor of parish roads cannot take the stones which the surveyor of a turnpike road may have already appropriated to his own use.

In some places, for want of other materials, clay is calcined, in order to produce a substance similar to brick. In this case, the surveyor is authorized to extract the clay, as well as to extract chalk or gravel. He may dry it on waste grounds or commons, and convey it away like any other species of material, by indemnifying individuals for any injury they may sustain through these operations.

I may mention the following regulations, as an example of the care with which the English Parliament provides against the occurrence of the slightest accidents which might arise from negligence in the execution of the public works.

When the road surveyor makes an excavation in any ground, for the purpose of extracting stone, gravel, &c., he must, forthwith surround it by a barrier or fence. He must fill it completely if he do not find the materials which he wished to extract. As soon as he has finished digging in a quarry, he must replace all the useless materials which he dug out of it; *and he must give a gentle slope to the edges of the excavation, in order to obviate the risk of accidents* *.

All expenses incurred by the purchase of materials, the indemnities paid to land-owners, the erection of finger-posts, &c., are defrayed out of funds raised by a general assessment made by the justices of the peace on the inhabitants of the parish; on condition, however, that this assessment do not exceed, for the road expenses, sixpence in the pound; that is to say, one-fortieth of the rental of the landed property. (This assessment has been increased by statute 55th of Geo. III.)

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* Any surveyor who may neglect to observe the regulations thus prescribed, must pay, for each offence, a fine amounting to 10*s*. If within six days after he receives notice from a justice of the peace to remedy this negligence, he do not obey the order, a new fine is exacted from him, amounting, according to circumstances, to from 2*l*. to 10*l*.

CHAPTER III.

Turnpike Roads.

THE progress of trade, and the increased means of conveyance which it requires, have gradually rendered the maintenance of the public roads more and more expensive. On those roads which were much frequented, the tax imposed and the statute-labour, not being found sufficient for the purpose, it was determined to erect turnpikes, for the purpose of exacting from saddle-horses, and beasts of burden, as well as from carriages, a toll which is applied to the maintenance of the road. The roads which are subject to these tolls are called *turnpike roads*. They were first established about a hundred and sixty years ago.

In spite of the miseries of civil war, and the disorders of anarchy which prevailed during the commonwealth in England,—in spite of the despotic oppressions to which that anarchy gave rise under Cromwell's reign, there cannot be a better proof of the progress of society, in regard to comfort and industry, than the measures to which Parliament was obliged to have recourse on the second year after the return of Charles II*. Among these measures were some for widening the roads, a proceeding rendered necessary by continually increasing traffic. Others provided the means of repairing the wear and tear of the public roads; in the following year, the turnpike duties were instituted*.

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* See Act 13 and 14 Car. II. cap. 6. In this act the breadth of wheels and the weight of carriages already began to be limited.

It was natural to expect that the people of England would behold with pleasure the establishment of a system calculated to relieve them in some degree from the burden of statute-labour; for this new system threw the principal charge on persons of property, who, by means of their horses and carriages, are the greatest destroyers of the roads. But the mob, with a blind disregard to their real interests, and with their characteristic hostility to all fiscal innovation, pulled down the first turnpikes which were erected; and it was found necessary to employ military force, to compel the people to respect this means of improving the condition of the public roads, for their own convenience and benefit! In France, during the Revolution, the government attempted to establish turnpikes on our great roads; but the people rose in the same manner to oppose the system. The Executive Directory, however, had not sufficient firmness to maintain this useful innovation, which it would be well to introduce again, and above all, to support with energy.

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* The first act in which these duties were specified, commences the Statute of the third Parliament held under Charles II. It relates to the road from London to Scotland, passing through Hertford, Cambridge, and Huntingdon.

A hundred and ten years after the establishment of turnpikes on the roads of Great Britain, Parliament deemed it necessary to combine in a single act (13th Geo. III., cap. 84.), all the laws relating to that subject. Subsequent enactments having modified many of the measures established by the general law, it became necessary to re-mould it entirely. This was done in 1820, 1821, 1822. In this last year appeared the 3d statute of Geo. IV. cap. 126, comprising every regulation which experience has shown to be most advantageous for the management of turnpike roads. We will proceed to cite the provisions of this new act, which differ from those we have mentioned on the subject of open roads.

In conformity with that great principle of the English constitution, that no tax shall be levied without the consent of the people, or of their representatives, it is impossible to establish any toll on the highway without the formal consent of Parliament.

The act which regulates the collection of this road tax, and which transforms an open road into a turnpike road, places the receipt and employment of the funds proceeding from the tolls, under the superintendance and direction of a number of persons called trustees. These trustees exercise their functions gratuitously. They compose what is called a trust, for directing and managing the labour, revenue, and expense of the roads.

It was complained that trustees had become far too numerous—a circumstance which prevented them from co-operating in an adequate way. This inconvenience is chiefly felt in the neighbourhood of London. Accordingly, one of the most effective measures proposed to Parliament for the better regulation of turnpike roads, has been to diminish the number of the trusts—by allotting to each of them the direction of a greater extent of road. Finally, it has been proposed to form a single trust from all those which superintended the labours and the expenditure of the roads in the neighbourhood of the metropolis, within a circuit of ten miles round London. (*Report made to the House of Commons on Turnpike Roads,* 1819. *See Chap. V. of this book.*)

Parliament sometimes appoints more than a hundred and twenty persons to form a trust. It would be better if a smaller number were appointed, and if the conditions necessary to be fulfilled by individuals before being admitted to such confidential situations, were more severely exacted. It is but just, however, to observe that the new act has rendered these conditions more difficult, which is considered an important improvement.

The justices of the peace in those counties through which a turnpike road passes, are included by right under the act among the number of trustees. Every other citizen must first prove that he possesses a certain fortune, before he can be admitted to this honorary office. He must prove that he enjoys an annual income amounting to 100*l.* sterling, arising from landed property, or that he is the presumptive heir of a person having an income of 200*l.* sterling, derived from landed property. By a special provision, if the road, or roads, or any part thereof, be situate within ten miles of the Royal Exchange in London, any person may become a trustee, if he possess 10,000*l.* worth of personal property, after the payment of his debts. Any individual exercising the functions of a trustee, without having taken his oath that he can fulfil one of these conditions, is subject to a fine of 50*l.*

Two very wise measures are provided by this act. It is required that a trustee should abstain from exercising his functions whenever his own private interests are concerned; and that no individual keeping a public-house, inn, tavern, *&c.*, can become a trustee, or possess any place deriving a salary from the trust.

The revenue arising from tolls is paid into the hands of a treasurer, by the receivers, who are obliged, under pain of a fine of 1*l.* for each offence, to present their accounts to the trustees, whenever they are called upon to do so.

The trustees hold an annual meeting for the purpose of examining completely the state of the accounts and the affairs which they direct. They also hold special sittings whenever they deem it necessary. Three members at least are required to constitute a special meeting, and seven to alter or revoke an order emanating from a preceding assembly. The object of a special meeting is required to be stated in the advertisement for the convocation, &c.

The trustees have the power of shortening, improving, or altering the direction of the road intrusted to them, as they may think proper. They cannot, however, deviate more than 100 yards from the old line of road, without the consent of the proprietor of the land crossed by the new line, who is besides indemnified for the alteration.

The act of Parliament authorizes the trustees to contract a loan, to provide the funds* necessary for making, repairing, or improving the roads. The interest of these funds is paid out of the proceeds of the tolls, and the capital is reimbursed from the same source.

The act for instituting each trust limits the rate of the tolls, and the number of the turnpikes, according to the probable balance of the income and expenditure. The trustees cannot exceed these limits; but they may diminish the toll, with the consent of the creditors of the road. They let out each turnpike by public auction, which is announced thirty days previous to the sale, in an advertisement, stating the net produce of the tolls, during the preceding year.

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* Any individual, who subscribes to a loan for constructing or maintaining a turnpike road, is liable to an action of debt for the recovery of the amount, if he do not come forward to fulfil his engagements within twenty-one days, reckoning from the period when he promised to furnish his funds.

On the erection of a new turnpike, the trustees are required to give notice that they will hold a general meeting in twenty-one days at the earliest, for the purpose of deciding whether or not it shall be erected, and in what situation it shall be placed.

In case the trustees should erect a turnpike, without observing the regulations of the act of parliament, by which their functions are assigned to them, or merely without the legal authority, the justices of the peace, at their quarter sessions, may give orders for its removal. The justices must then address their *exequator* to the high sheriff of the county, as the representative of the executive power.

The works for the support of toll roads, are under the superintendence of special surveyors, who are appointed by the trustees, as are also the treasurer of the road, the toll collectors, *&c.* All these persons must furnish a good security for the sums that are lodged in their hands.

As the inhabitants of a parish through which a turnpike road runs, are the first to derive advantage from it, with respect to their agriculture, trade, and manufactures, the legislature has deemed it advisable to oblige these inhabitants to defray a special portion of the expense of supporting the road*.—

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* This measure is the more just, since by art. 6, act 84 of the 13th Geo. III. vehicles of every description employed in agricultural labour, are exempt from the payment of tolls. However,

They are therefore required to furnish annually, three days' labour, according to the same regulations as those that are observed in the labour of free parish roads. The law also permits an equivalent compensation in money to be substituted for the road labour.

The surveyors of turnpike roads must employ the labour and money supplied by each parish, on that part of the road which is situated within the parish, under pain of being fined for each transgression of the regulation. If several turnpike roads run through one parish, it may happen that three days' labour are not sufficient for their support; the justices of the peace assembled at the quarter sessions, are in that case authorized to prescribe a new division of labour between the open and the turnpike roads. They must, however, previously take the opinion of the surveyors of these different roads.

If a parish neglect to contribute, as the law requires, to the repair of a turnpike road, the court to which the case is referred fines the parish liable, in damages and expenses, which are levied by assessment upon all the inhabitants. The amount is directly lodged in the hands of the treasurer of the road.

If the revenues of a turnpike road are sufficient for its own support, as well as for the payment of its

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on some roads, parliament authorizes for the passage of carts, *&c.*, laden with certain kinds of fossil manure, the exactions of *a part* of the tax fixed for other descriptions of loads.

debts, the justices of the peace in each district, when assembled at the quarter sessions, may, on the demand of the parish, and after an examination of the receipts and expenses, order that the labour due by the inhabitants for the support of the road, shall be transferred to other roads within the parish.

All the police regulations for ensuring the preservation and free traffic of parish roads, are applicable to turnpike roads. The surveyor, like the surveyor of parish roads, possesses the right of compelling the proprietors of lands adjacent to the public road, to make and support ditches, drains, &c. The surveyor must obtain the authority of a justice of the peace before he can collect in a field, the stones necessary for the road work, at least, if the proprietor of the field should refuse to give his consent for that purpose. In all cases the trustees are bound to pay for the materials which are taken from enclosed lands, for the works under their superintendence.

On turnpike roads it is the business of the trustees to order the fixing up of mile-stones, and the erection of finger-posts at cross-roads and in dangerous places, on open roads; all complaints in this respect are within the jurisdiction of the justices of the peace.

The law adjudges the punishment of felony, that is to say, capital punishment * for the wilful destruc-

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* This is a mistake, the act prescribes seven years' transportation, or a mitigated punishment, as in cases of petit larceny.—*Translator.*

tion of a turnpike or of a weighing machine, as well as for the destruction of posts, parapets, chains, bars, or any fences belonging to a turnpike *. Any individual who may attempt to force a turnpike, or to assault the collectors, is liable to a penalty which, according to circumstances, may amount to from 2*l*. to 10*l*. If the offender be unable to pay the fine he may be sentenced to three months' imprisonment †.

The law empowers trustees to prosecute any individual who may damage the public road of which they have the superintendence ‡. All fines exacted for the commission of damage, or for infringements of the regulations of the turnpike roads, are applied to the support of those roads.

The justices of the peace may be trustees and even creditors of the roads, without ceasing, on that account, to exercise their judiciary power, in the different measures which require application of the turnpike act. A sheriff, deputy, or bailiff, who may refuse or even neglect, in any particular, to assist in enforcing this act, is fined 10*l.* for every instance of refusal or neglect which may prove detrimental to the public service.

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* The damages and expenses incurred by such an offence are paid by the hundred in which the offence was committed. But if, within twelve months after the commission of the depredation the offender be detected and condemned, the fine which he is bound to pay, goes by right to the inhabitants of the hundred.

† If the offender should be without the jurisdiction of the justices of the peace, where the crime was committed, the sentence of these justices is transmitted to those of the jurisdiction in which the offender resides, that it may be executed voluntarily, or by compulsion, or, if necessary, by seizure. The testimony of a respectable inhabitant of the parish is sufficient for the conviction of an offender, taken in the fact on a turnpike road.

‡ The expenses of the prosecution are paid out of the revenues of the trust.

Far from limiting itself to the general measures which we have just described, the British Government conceived that to specify the regulations to be observed with respect to the weight of waggons, the number of horses in each team, the breadth of the wheels, the length of the axle, would tend effectually to the preservation of the roads. So early as the year 1662, the English Parliament laid down the basis of these regulations [*]. In treating of commercial conveyances we will give a list of the regulations thus determined by law, and estimate their effect on the preservation of the roads.

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[*] Part IV. *Commercial Conveyances.*

CHAPTER IV.

Private Roads and Statute Roads.

Though the two classes of roads of which we are now about to treat, are managed in a way essentially different from each other, yet we shall conclude our account of them in one chapter, because they both form exceptions far less extended than the two kinds of roads which have been describing in the preceding chapters:

Private Roads

May be reduced to those which are made by an individual across his own or his neighbours' grounds, to communicate with the public road; for example, in order to convey to the public road the produce of his quarries, mines, manufactures, *&c.* An individual requires no permission to make a road on his own estate, but he must have the authority of an Act of Parliament for extending that road over his neighbours' land. The conditions on which this authority is granted, as well as all the forms to be observed in purchasing the ground for the road, are the same as the conditions and forms for the grant of a canal, when the individual to whom the grant is made, finds it necessary to encroach upon ground belonging to other persons. For the sake of avoiding useless repetition, we may refer to the second book of the present work, where the legislative measures here alluded to are developed as fully as the importance of the subject demands.

Statute Roads.

The general spirit of the English legislature, is, as we have already shewn, to assign to parishes and local associations or trusts, the duty of making and supporting open and turnpike roads. The expenses required in these labours are every where defrayed by the inhabitants of the neighbourhood who more particularly derive advantage from them; and also by the proprietors of the carriages, carts, *&c.*, which pass over every part of the road, under the management of a parish or a trust. However, there are cases in which certain roads cannot be made and kept in good repair by the mere resources of the parishes which immediately profit by them. Such for example are the principal roads made through a poor and not easily accessible country, for the purpose of establishing important commercial communications, securing internal tranquillity, or providing defence against foreign enemies. We shall now advert to two remarkable examples of statute roads established on the above considerations.

I. *Civil and Commercial Roads.*

The Irish Parliament having ceased to exist in the year 1800, the legislative power of that kingdom was thenceforward incorporated with the power of the British Parliament. Thus the administration and political relations between Great Britain and the island associated to her empire, have been more numerous, extensive, and active. The members sent by Ireland to the House of Commons, and the Irish Peers who have seats in the House of Lords, visit London during every parliamentary session, attended by their families, and a multitude of individuals of all ranks and professions are also obliged to repair to London at these periods, to take part in the various and important affairs connected with the proceedings of Parliament. A centre of power, in moving from place to place is followed by a host of ambitious intriguers, whose whole occupation consists in following the footsteps of the distributors of wealth and honour. After the union the most distinguished portion of the Irish nobility and gentry, instead of being called to Dublin, to administer laws to Ireland, were called to London. It has become also the fashion for idle persons of fortune, to spend the period of the parliamentary session in the British capital. Personal communication between England and Ireland has by this means become far more frequent and extensive than before the close of the last century. At the same time, the two countries having experienced, though in very different degrees, the progress of wealth and industry, their mutual trade has been increased by this progress. Conveyance by land and by sea has also been augmented in an equal proportion, and correspondence of every kind has acquired greater importance and activity. The necessity of favouring this activity by improving the roads destined to connect the capitals of the two kingdoms, has been daily more and more forcibly felt.

From 1803 to 1814 the war between France and England, and the enormous expense incurred by the conflict, caused the British Government to postpone until the restoration of peace, the measures necessary for attaining this great object of national prosperity. But as early as 1815 Parliament granted 20,000*l.* for improving the communications of the public roads between London and Dublin. The whole of this sum was appropriated to the roads which pass through Wales.

This country which is mountainous throughout its whole extent, and extremely barren in many parts, was unable from the produce of its road labour and toll duties to execute the great improvement made in the roads which pass through it, and which from the very nature of their local situation demand considerable sacrifices. In these improvements Parliament regarded the particular advantage of the inhabitants of Wales merely as an object of secondary consideration; and it would consequently have been very unjust to load the inhabitants with such a burthen of expense. Such are the reasons assigned for the vast sum allotted by the Treasury to the roads leading to Ireland.

In the years 1810—11—15 and 17 Parliament appointed committees of inquiry to examine the state of the roads from London to Dublin. The reports made by these committees shew the serious inconveniences and dangers to which travellers were exposed.

This road, so essential for maintaining the communication between six or seven millions of His Majesty's subjects on one side of the Irish channel, and twelve millions on the other, can never be put into a proper state of repair and safety, if it is left to local interests to support and manage it; in place of its being considered by parliament as a work of great national importance, affecting in a greater or less degree, all the inhabitants of the united kingdom.

In respect to the effect of applying public money to execute a work of this kind, upon the finances of the country, your Committee conceive that such an application of the public money ought not to be considered as such an expenditure as contributes in any degree to impoverish the country, or to diminish the general wealth of it, and therefore as inconsistent with a proper spirit of retrenchment. Provided the money is honestly applied in executing the work, and that the consequence of improving the communication is to lead the industry, skill, and capital, of these countries into more active employment, and thus to become more productive than they otherwise would be; the capital expended in the first instance will not be like a capital expended in the ordinary expenses of the state, and be thus taken away from the productive industry of the country to exist no more, but it will be employed productively, that is to say, in a way to assist and promote the production of other capital, and in the end, it will be repaid to the state by the increased public revenue, which will be the necessary consequence of increased production in the first place, and then of increased national wealth.

If the whole money is faithfully expended in labour and materials in making the road in a substantial and lasting manner, it does a public good by the employment it gives and by the purchases it makes; it is attended with a great saving of capital in diminishing the waste of horses and carriages; it admits of those whose time is valuable to them, having more of it to apply to their business; it affords a great personal convenience and some saving of expense to all travellers; and finally, it contributes in a great variety of ways, to enable many persons to make more by their professions and trades than they otherwise could make.

Your Committee therefore confidently trust, that as parliament has recognised, in so many sessions, the principle of establishing a safe and convenient road between London and Holyhead, in order more completely to identify the interests of England and Ireland, and thus to lead to the mutual benefit of both countries, it will persevere in voting further grants of public money to complete it. In respect to the convenience of Irish travellers, your Committee regard this as a secondary and inferior object to that of contributing to the internal improvement of Ireland by opening a more easy and direct communication between it and the highly improved condition of England.

We will now quote the act relative to the works for establishing those communications, 55 Geo. III. c. 152, (July 11, 1815.)

Most Gracious Sovereign,

We your Majesty's most dutiful and loyal subjects, the Commons of the united kingdom of Great Britain and Ireland in parliament assembled, having granted to your Majesty the sum of 20,000*l.* for this present year, towards defraying the expense of repairing, altering, or constructing, such roads as shall appear to be most immediately necessary for the facilitating the communication between London and Holyhead by Chester, and between London and Bangor-Ferry, by Shrewsbury, whereby the intercourse between Great Britain and Ireland will be beneficially promoted; do most humbly beseech your Majesty that it may be enacted, and be it enacted by the King's Most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons in this present parliament assembled, and by the authority of the same:—That out of any monies granted for the supply of the present year, there shall and may be issued and paid at the receipt of his Majesty's Exchequer in Great Britain, the sum of 20,000*l.*, without any deduction whatever to the Commissioners hereinafter named, which sum shall be applied by the said Commissioners towards the repairing, altering, making, or constructing such roads as shall be judged proper, in the manner hereinafter directed, and not for any other use whatever.

For the management and superintendence of this business, Parliament appointed ten special commissioners, at the head of whom are the Chancellor of the Exchequer for Ireland, the Chief Secretary of the Lord Lieutenant of Ireland, and the First Commissioner of Crown Lands. From time to time these commissioners must assemble in London, one of the three functionaries, who have just been mentioned, acting as chairman according to precedence. They decide by a plurality of votes, on the affairs consigned to them. If one should die or give in his resignation, his successor is appointed by the ministers.

The Act of Parliament enjoins the Lords of the Treasury to engage professional men to inspect the roads which are to be repaired at the expense of the public treasury. The reports of these inspectors must be signed upon oath, and must contain an estimate of the expense of the works to be undertaken. These reports must afterwards be addressed to the special commissioners, who determine on what parts of the roads the operations shall commence. They must publish in the London Gazette a list and a description of the works to be undertaken; and this list must be addressed to the justices of the peace at the general session in every county, containing the roads on which the works are to be bestowed. The special commissioners must treat with the persons who make proposals in consequence of these advertisements.

As soon as the commissioners determine on the succession and order of the works, they must open in their books an account for each contract. To liquidate this account they are required to deposit a sum equal to the amount of the estimate. This being done, the contractor may commence; but he must do so without delay.

The commissioners are invested with powers similar to those granted to the trustees of turnpike roads: 1st, for the purchase of land necessary for changing the direction of roads, either by amicable adjustment, or according to the estimate of a jury composed of twelve individuals *; 2d, to extract

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* An excellent clause in these regulations prescribes that the money paid for ground purchased for the public use from the

from parochial or private ground the materials requisite for the road labour; 3d, to indemnify the land owners for the damage they may sustain in this extraction of materials, either by an amicable adjustment, or by the decision of justices of the peace; 4th, for engaging clerks and agents to direct, superintend, and execute the works; 5th, for fixing the salaries of the individuals employed, according to the importance, difficulty, and fatigue required in their services. The law prescribes the modes of proceeding against offenders, whom the commissioners are authorized to prosecute.

The following was the course pursued by the commissioners, in fulfilment of the duties assigned to them. They first appointed an engineer in chief (Mr. Telford), who drew up a general plan of the roads which were to be improved and perfected. To this he added plans, profiles, details, and estimates of the works to be undertaken. The commissioners having next pointed out those inconvenient and dangerous parts of the road, on which it was desirable to *commence* the repairs, divided them into lots, each of which was to be the object of a separate contract. The plans and estimates

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property of a minor, or a lunatic, or a corporation, shall be lodged in the public funds, or by trust, in the hands of two persons appointed to receive the deposit. These sums cannot afterwards be touched by guardians, trustees, *&c.*, except by the approbation and direction of the Court of Chancery.

were deposited in the neighbourhood of these lots, in the care of persons appointed to shew them. The proposals for the contracts were addressed to the secretary of the commissioners; and on an appointed day all the letters were opened. The most moderate offer was accepted for each lot, provided it was made by a person of good character, furnishing sufficient security. The contractors were required to furnish security, and to forego receiving payment of *one-eighth* of the amount of each contract, until the works should be completely finished, examined, and approved by the engineers, acting under the direction of the commissioners. In order that a perpetual inspection might be kept up, the works were under the superintendence of a resident engineer, and an inspector, intrusted with a number of lots included within a distance over which the vigilance of a single individual might be effectually maintained.

Every month, the work was measured, and an estimate of the quantity completed was sent to the office of the commissioners. The contractor was paid seven-eighths of the amount of this estimate. The complete estimate of the works being at length drawn up and sent in, the works themselves underwent a general inspection, for the purpose of ascertaining that they were perfectly good, and conformable with the agreements. If any thing required rectifying or finishing, the contractor was compelled to remedy the deficiency before he received payment of the last instalment of the sum for which he had bargained.

II. *Military and Commercial Roads.*

We will take, by way of example, those of the Highlands of Scotland. Though laid out according to a plan of attack and defence, without regard to ascents and descents within the limits in which an army may pass, they have become extremely useful in a country destitute of better roads. They afford proofs of the advantage to be derived from a good system of commercial roads.

These military roads were commenced in 1732; and so early as 1745, they opened a communication from Stirling to Inverness, and from Inverness to Fort William. The rebellion of 1745 rendered still more obvious the importance of multiplying them. The soldiers stationed in the Highlands for the purpose of maintaining subordination, were employed as labourers; and military roads, measuring to the extent of about 750 miles, were successively laid out. Of these about 550 miles were still employed in the year 1803. These roads were supported at the expense of the public treasury, though their importance, in a military point of view, was at an end*.

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* General Abercrombie, who was killed at Aboukir, having been, some years previously, appointed inspector of these roads, declared officially that they were not necessary for military purposes.

In 1802, the state of the Highlands of Scotland claimed the attention of government; and in 1803, the Treasury gave orders for a survey of the coasts and central parts in that quarter of the British dominions. The report* of this survey included a general plan of commercial communications. It was submitted to Parliament, and then referred to a special committee, by whom four reports were made to the House of Commons, as the ground-work of the important laws that were to be framed on this subject.

A country, like the Highlands of Scotland, intersected by numerous torrents, and rivers of rapid current, and subject to frequent falls of rain and snow, presented difficulties, and demanded expenses, for meeting which the mere resources of the owners of the productive part of the soil were insufficient.

For this reason, Parliament determined to defray, out of the public treasury, one half the expense of constructing the roads and bridges, which it was deemed expedient to establish immediately, for the purpose of facilitating commercial communications. Commissioners were appointed to superintend the application of the funds granted by virtue of this decision (43d Geo. III.)

In 1821, these commissioners, after having exercised their functions for eighteen years, rendered an account of their operations, in nine reports, which were printed by order of Parliament. These reports, from which most of the facts here recorded have been obtained, are highly valuable documents relative to the communications of the Highlands.

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* This report, and the plan it contained, were drawn up by Mr. Telford.

The roads have been traced out on an extensively conceived plan, so as to facilitate the communications of the Highlanders, the transport of their flocks, and of all productions which they import or export.

The inhabitants of these remote regions soon experienced all the advantage of the works authorized by Parliament. In the year 1804, the county of Inverness obtained permission to tax itself, in order to reimburse the land-owners who had advanced funds, or who had mortgaged their estates, to supply the loans necessary for the establishment of the roads and bridges. In the two following years the other counties imitated this example; and the improvements soon extended over a superficies of ground exceeding 500 square miles.

Since the year 1803, Parliament has successively granted for the works of the Highland roads, *&c.*—

	£.252,390
And the inhabitants have contributed	201,799*
Total	£.454,189

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* The sum paid by the inhabitants is less than that paid by the government, because the preliminary expenses defrayed by the

This sum was employed over about 870 miles of road, and was applied to the erection of several considerable bridges, exclusive of those comprised in the contracts for laying out roads*.

The inhabitants of the Highlands, not content with having contributed upwards of 200,000*l.* to the establishment of their roads, have offered, if government will continue to support half the expense, to make an additional advance of about 80,000*l.* for the same purpose. They experience the full advantage of these sacrifices. They wish to ensure the excellence of their roads by works which are necessarily very expensive: they are willing themselves to pay a great portion of the expense thus incurred; and yet the Highlands of Scotland are poorer than any portion of the British dominions.

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treasury, for technical and legal operations were not taken into account. It was according to the other expenses only, that the sum furnished by the inhabitants was determined.

* Mr. Telford, the author of the Parliamentary Report of 1802, was appointed to direct all these works. The average sum paid for the laying out or the restoration of roads was within 250*l.* per thousand yards. During the seventeen years occupied by these works, the expense of the direction and the superintendence of agents of every kind, from the principal engineer to the lowest surveyor, was 30,000*l.* (For the details of this subject, see p. 6, Ninth Report.) For the remuneration of the solicitor engaged to manage the legal business connected with the works, and to examine the securities offered for contracts (there were in all 120 different contracts), for the expense of stamps, advertisements inserted in the public journals, placards and postage, 10,000*l.* were paid.

What an example for our mountainous districts, such as Auvergne, Cevennes, Aveiron, the Vosges, Jura, the Upper and Lower Alps, and the Eastern and Western Pyrenees!

The roads, which were originally made purely for military objects, are now transformed into turnpike roads in the southern Highland counties, which are further advanced than the rest in manufactures and trade. If the northern counties continue their improvements, the roads in those parts must necessarily undergo a similar change.

But a great number of statute roads require to be kept in a constant state of repair; and for this essential object vast expense is not so necessary as unremitting attention. In a mountainous country, subject to frequent and violent storms, the examinations of the road-surveyor should be careful and often repeated, in order to arrest in due time the ravages of torrents, which may intersect the road with ravines, or cover it with stones dislodged by the current of the waters.

The commissioners in their ninth report observe, that the Highlanders have not manifested an inclination to support their roads, equal to their liberality in defraying the expense of first laying them out.

The military roads have been constantly supported at the expense of the public treasury, and they have cost 5,000*l.* annually. It is now estimated that all the roads in the Highlands may be maintained for 10,000*l.* per annum. Parliament pays the half of this sum (59th Geo. III., cap. 135); and it is employed over 1182 miles of road. This makes for each mile 8*l.* 9*s.*, from which must be deducted 1*l.* 4*s.* 6*d.*, to defray the charges of superintendence, and the salaries, travelling expenses, *&c.*, of a surveyor and six deputy surveyors.—(*9th Report on the Roads of the Highlands of Scotland.*)

General Table of the length in miles of the Highland roads which are to be kept in constant repair, according to Act 59 *Geo. III., cap.* 135.

IN THE COUNTIES OF	ROADS.		ROADS OF DINGWALL	TOTAL.
	Statute.	*Military.*		
Inverness	346	176		522
Argyle	134	80		214
Ross and Cromarty	180		25	205
Sutherland	95			95
Caithness	54			54
Elgin or Moray	7½			7½
Bute	16¾	27		43¾
Aberdeen	16			16
Nairn	14			14
Bamff	2¼			2¼
Total.	866	283	25	1174

The act of the 56th Geo. III., cap. 83, grants 50,000*l.* for the improvement of a great portion of the road between Carlisle and Glasgow. This road, which joins England and Scotland in the westerly direction, is about 100 miles in length, and there are several bridges to be built along it. The general management of this road is consigned to the commissioners of the Highland roads, and Mr. Telford is the engineer intrusted with the special direction of the works.

CHAPTER V.

Parliamentary Inquiries and Reports relative to Roads.

The English Parliament has not limited itself to the establishment of general laws for regulating the police and the works of the roads. Special committees have frequently been appointed for inquiring into the state of the public roads in different parts of the kingdom, and to deliberate on the means of rendering the passage of wheeled vehicles easy, economical, and rapid. These two great objects of general utility, of which the one cannot attain perfection without the other, have been justly regarded by Parliament as inseparable.

The solicitude evinced on this subject by the British Parliament, together with the hints and improvements it has called forth, are worthy the attention of statesmen in every civilized nation; but particularly in a country which, like France, enjoys a system of government established on the same principles and in the same forms as that of England. The proceedings of the British Parliament show how highly that great legislative body appreciates the importance of supporting and improving the public roads. They present to our Chambers examples of preparatory measures and forms of inquiry worthy to be imitated, in the patient and laborious investigation of the causes which may impede facility, safety, and rapidity of conveyance, and of the regulations which a well organized police may adopt, to maintain order in the public roads. We must particularly remark the appeal made by the British Legislature to the evidence of men of talent, for ascertaining the best methods of laying out, supporting, and repairing roads; and the reference which is made to experience to determine what form of wheels and vehicles is best calculated to favour, in a due degree, the interest of trade,—that is to say, to secure economy and celerity of conveyance, with the preservation of the public roads, and a consequent diminution of expense to the persons by whom the roads are supported.

An analysis of some of the reports made to the House of Commons on these different subjects, will be more useful, and will produce a more powerful and lasting impression, than any general considerations and prolix demonstrations on this subject.

In 1808, the House of Commons appointed a special committee, which was instructed—1st, to examine all the acts then in force relative to the use of broad wheels; 2d, to determine what form of wheel is most favourable for the draught of horses and the preservation of roads; 3d, to propose new regulations to contribute to this preservation; 4th, to trace out the measures proper to be adopted with the view of rendering more effectual the acts passed in 1788 and 1790, for limiting the number of persons to be carried by stage coaches, both inside and outside, and the act passed in 1808 for subjecting the drivers of stage coaches to certain regulations.

The committee, in the first place, divided its labours into three parts, relating, 1st, to the form of wheels; 2d, to the construction of vehicles; and 3d, to the laying out of roads.

The first question is treated with all desirable fulness, in a report printed on the 18th of July, 1806, and also in a subsequent report. With regard to the second question, the committee were specially to inquire, whether it was most advantageous to employ heavy waggons or light carts drawn by a single horse; whether it was expedient to prefer the power of the horse to that of the ox, or reciprocally, *&c.*

To resolve these two first questions, the committee called into requisition the information and experience of civil engineers, post-masters, contractors for stage coaches, *&c.*, coachmakers, cartwrights, and mechanicians. They were examined separately on every point which bore a direct or indirect reference to the subjects with which they were acquainted. They were requested to state the results of their observations, the positive facts they had collected, and the improvements they had to suggest. These examinations, which develope the information that has been derived from experience, and which contain descriptions of new measures and new operations, accompanied by the plans necessary for reference, are printed as appendices to the reports of 1806 and 1808. These important documents have supplied us with a multitude of facts highly important both in theory and practice, which we shall develope in the second section of the present work, in treating of land conveyance.

The third question, relative to the laying out of roads, was wisely referred by Parliament to the same committee that was appointed to inquire into the best plan of constructing wheeled vehicles; for, as we have already stated in other terms, in order to attain perfection, it is necessary—1st, that the roads should in the highest degree favour facility, safety, and rapidity of motion; and 2d, that vehicles should be constructed so as to preserve, as far as possible, the primitive form and quality of the roads.

The English have been long seeking to combine these great objects of public utility; and they have lately succeeded in so doing in a remarkable degree. This is plainly demonstrated in the report made in 1819, on the general state of the roads in England; and in the reports that have been published relative to the road from London to Holyhead.

The efficacy of the measures latterly adopted by the most skilful engineers in Great Britain, is confirmed—1st, by the evidence of post-masters and contractors for stage coaches, *&c.*, who in their examinations affirm, that their horses go faster, draw greater weight, and yet are not so soon worn out on the new roads as on the old ones; 2d, by the clerks of trusts, who affirm that the expense of supporting roads is considerably diminished by the new plan, &c.

These parliamentary reports have therefore the advantage of presenting at once the new views and useful suggestions of the most skilful professional men; the results of experiments made for the express purpose, or collected by attentive and unremitting observation; the evidence of individuals whose interests are entirely opposed, or at least wholly unconnected. Thus the committee of a parliamentary inquiry relative to the great question of conveyance, consult the post-masters, who only require that the engineers should construct a road not very soft, whatever may be the expense attending it. They consult the clerks of trusts who principally demand one thing more, namely, an economical mode of laying out and maintaining the public road, so as to incur the least possible expense, at the expiration of a given time. Finally, they consult the traveller, who (if he be conveyed by any but his own horses, as for example in a post chaise or a stage coach) without caring whether the roads be hard or soft, cheap or expensive in their construction or support, desires, above all, that they should be smooth and perfectly level, so that he may not be incommoded by jolting.

After consulting by turns these varying interests and opinions, the parliamentary committees, acting as legislative juries appointed to propose measures for ensuring the greatest public advantage, finally present to the House of Commons the result of their inquiries, and the mass of facts they have elicited.

By an acceptation of language no less just than forcible, the examinations themselves, the documents which support the testimony of the professional men examined; in a word, every thing on which the report is founded, is, in the English parliamentary style, called the *evidence* of the inquiry, This evidence is always printed at the end of the report; and the public are by this means enabled to form their own judgment on the questions submitted to the consideration of Parliament. The periodical writers and economists, political and technical, vie with each other in propagating their opinions on the subject under discussion; some for the purpose of supporting, others of opposing, the ideas expressed in the report. Thus information is brought out from all sides; and when the moment arrives at which Parliament proposes to establish laws on the result of these preparatory measures, the subject is so generally understood, that the most judicious decisions may be anticipated.

Yet, as all human proceedings are exposed to error, the committees of inquiry do not always present the most perfect measures for the acceptance of the legislature. These measures frequently exhibit the traces of public or professional prejudice, which are not easily avoided. Private interests and passions occasionally impede the strict impartiality of the inquiries. But the publicity given to the operations of each committee acts as a check to abuse, and points out every fault that may be committed. Time, that great investigator of truth, discovers it the sooner, when even these illusions of error are thus compelled to be exhibited in broad day. In this the British Parliament adopts the surest and most speedy course for finally arriving at the measures most consistent with the public interest.

We have yet one general observation to make on the part which the legislative authority deems it necessary to take in the works of the public roads. Parliament wishes to ascertain every fact connected with the economy, safety, and comfort of public communication, considered in its most essential relations; but it discourages the executive power from taking upon itself the management of works * which may be safely intrusted to the zeal

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* It was proposed to the members of the committee of inquiry appointed in 1819, to establish a general management of turnpike roads, to be under the superintendence and patronage of some department of the ministry. But the suggestion was rejected, on the ground *that it was unreasonable, and contrary to the public interest.* The committee considers, says the report, that there are many important reasons to determine Parliament to leave the complete direction of the affairs of the different trusts in the hands of those trustees to whom the law has at present confided them. The experience, the character, and the interests of these trustees furnish to the public the surest pledges of their skill, attention, and economy.

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and the well-understood interest of the public. Thus the construction and support of parish roads are left to the parishes to which they belong; the laying out and preservation of turnpike roads are consigned to trusts; and it is the business of private individuals and their trustees to execute the private roads that may be exclusively useful to themselves. The government, however, reserves to itself, 1st, the execution and superintendence of the roads that may be necessary for the defence or tranquillity of the country; 2d, the laying out or making extensive improvements on the roads essential to the general prosperity of the kingdom, but which are so expensive that it would be unjust or impossible to require that the districts in which they are situated should alone pay for works, the advantage of which they do not exclusively enjoy; these great operations being completed, the local authorities are intrusted with the superintendence and support of roads, which have been

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The functions of trustees are gratuitous, as has already been observed in the preceding chapter, and the committee of 1819 cautiously avoided proposing that they should be otherwise. The committee merely wished, by consigning to the management of a single trust all the turnpike roads within a circuit round London, to render them a model to the rest of the kingdom, by adopting, on these roads, the best system of construction, repair, and support. Thus, added the committee, the spirit of improvement spreading from the centre to the circumference would rapidly extend itself into every part of the kingdom, and would produce those numerous public and private advantages which a former committee hoped to obtain in an object of such great national interest.

created or perfected for the benefit of trade. Sometimes, as with respect to the commercial roads of the Highlands of Scotland, the object of which is to promote the physical improvement and civilization of a country, whose soil and climate present extraordinary difficulties to be surmounted, government offers to defray one half the expense necessary to provide for and facilitate public communication.—These measures tend to excite the emulation and patriotism of the people, even in the most remote quarters of the empire.

In times of difficulty, as, for example, in rigorous winters, when the severity of the climate is rendered more painful by the dearness of provisions; and at those periods in which agriculture and trade laboured under a depression, Parliament authorized the ministry to advance funds to parishes and trusts to defray the expense of extraordinary road works*.—Even during the flourishing periods, if a trust should be inclined to undertake an improvement which is calculated to produce a sufficient revenue to cover the expense, Parliament grants a similar advance on the Exchequer.

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* From the 6th report of the committee appointed to examine the works of the road from London to Holyhead, it appears, that in 1817 the St. Alban's trust obtained from the Exchequer 6,000*l.* for the purpose of diminishing the abrupt slope of a hill. The additional toll duties which the trustees were, in consequence, authorized to levy, produced 12 per cent. interest on the capital borrowed, which will therefore soon be repaid. The public will then freely enjoy the benefit of the new improvement. The Wolverhampton trust has followed this example.

In England, therefore, the supreme authority grants to the citizens credit and funds, to enable them to execute works which are no less interesting to the government than to themselves; while in other countries the people are required to pay their funds into the treasury, so that the government may execute, when and how it pleases, works in which the public alone are concerned. In the following chapter we shall more particularly advert to this important point.

How far are we from sharing the spirit of the ministry and parliament of Great Britain! In France, even the care of a by-path is scarcely ever intrusted to the inhabitants of the neighbourhood. Before a basket-full of stones can be laid down on the most obscure departmental road, it is indispensably necessary that the cost of these materials should form an item, first in the arrondissement budget, then in the departmental budget, and afterwards be submitted to the grand council of roads and bridges in an office at Paris, at the distance of two hundred leagues from the spot where the work is to be executed. The paltry charge in question having passed through all the delays of profound investigation, the desired permission is granted; provided, however, that not the slightest neglect of form should render it necessary to undertake, for a second time, the task of exploring the immense labyrinth by an inverse course. Tthe accounts, after passing through an almost endless series of progressive operations, retrograde with official delay, to their first source! An engineer is then permitted to execute at his leisure the trifling repair of the road which has occasioned this long and appalling train of official formalities, ascending and descending.

Though the English parliament takes no share in providing the chief portion of the funds applied to the service of the roads, yet it is nevertheless convinced of the importance of requiring annual returns to show the state of the management of these roads. We will enter upon a few important details on this subject.

Road Expenses.

In England, as we have already observed in Chapter II. the inhabitants of the different parishes enjoy the right of taxing themselves for the support of their poor and their roads, according to the amount of their property in land, houses, and cattle. The taxes thus raised for the twofold object of maintaining the poor and the roads, are called, without distinction *poor-rates*. Thus many foreign writers, in alluding to the expense of supporting the poor in England, have fallen into the error of assigning to this sole object the whole amount of the parish taxes, a considerable portion of which is directed to the support of the roads*.

On the 1st of June, 1818, in consequence of the measures prescribed by the act 55 Geo. III. c. 47, a return for each county, and then a general recapitulation was laid before the House of Commons, in order to shew the annual cost of supporting the roads, either by statute labour or by a supplement in money raised by the poor rates.

In order to obtain, with the greatest certainty an average amount, the expense of maintaining the public roads was calculated from the estimates of three consecutive years, from 1811 to 1814. These estimates shew separately the total length of paved streets, turnpike roads, and common open roads. By the following abstract of these returns it will be seen that paved streets and turnpike roads form only a proportion of *one-fifth* of the length of open parish roads:—

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* Mr. Dupin has confounded *poor* rates and *parochial* rates. In all parishes the amount of the expenditure upon the poor and the highways are separated by law; though some portion of the poor's rate is occasionally applied to the employment of road labourers.—*Translator.*

PUBLIC CARRIAGE ROADS IN ENGLAND.	YEARS ENDING IN OCTOBER.		
	1812.	1813.	1814.
Paved Streets and Turnpike Roads..	19,114	19,132½	19,178
Other Roads....................	95,105	95,142½	95,184
Total length....	114,219	114,275.0	114,362
Contributions in labour (pds. st.).....	515,508	539,522	551,241
Contributions in money...........	271,512	276,947	287,059
Taxes levied for the roads..........	570,754	613,604	621,512
Total.....	1,357,774	1,430,073	1,459,812
Expense of preparing documents, *&c.*	21,499	26,252	25,700

Thus it appears that the average annual expenses of all the roads in England, were from 1811 to 1814 as follows:—

Contributions in labour - -	£535,423
Ditto in money - - -	278,506
Sums raised by rate - - -	601,954
Total - - - - -	£ 1,415,883

This gives 12*l.* 7*s.* 6*d.*[*] for the average expense of maintaining each mile of open road.

According to a report made to the House of Commons on the 10th of June, 1821, the total amount of the sums levied in a single year on turnpike roads, amounts to 970,618*l.* This gives the average value of 47*l.* 18*s.* for the support of each mile of paved street and turnpike road. By adding the contributions in labour, the expense will amount to about 51*l.* per mile.

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[*] In this calculation I have deducted from the total amount of the expense of road labour, the three days' labour which is allowed for turnpike roads; while six are allowed for open parish roads. *See Chap. II. of the present work.*

This revenue, immense as it is, is not sufficient for the construction of new roads, and the support of those that are already established. The different trusts have contracted debts, for which the rentals of each county are responsible. The total amount of these debts, at the period of the inquiry, of which the report to which we have above alluded gives the result, was 3,874,254*l.*; that is to say, that these debts then equalled four years' revenue. It is affirmed, that if the same calculation were made for Wales, Scotland, and Ireland, the general amount of the debt of the turnpike roads would amount to seven millions sterling. The chief portion of this enormous debt was contracted for the purpose of undertaking extensive new works and improvements, to increase the utility and excellence of the public roads. In spite of the amount of these first sacrifices, such is the confidence and enterprising spirit of the British land-owner, that in every part of the three kingdoms new roads are daily laid out, and old ones altered or improved. For the execution of these works loans continue to be contracted on the securities guaranteed by new acts of parliament. Such are the results that may be expected from the energy of a people left to themselves, and excited by the spirit of patriotism.

In France, during a period of profound peace, the government does not grant, for the support of our roads, *one third* of the amount which is supplied by the public in England alone, of which the superficies does not equal *one third* of France! And the degree of benefit which both nations derive from the good or bad condition of the public roads, is precisely in proportion to the sacrifices which are made by the people in the one country, and the government in the other. Can any reasons be urged in favour of public exertions, more convincing than comparisons founded on such striking facts as these!

BOOK II.

LEGISLATION RELATIVE TO WATER CONVEYANCE.

CHAPTER I.

Management of Rivers, Canals, &c.

By water conveyance, I mean the rivers and canals which serve for the purposes of commercial transport, and also the aqueducts by which water itself is the object of commercial transport.

In England water conveyance is not regulated by a general administration: its management, its works, and its police are all local. It is under the superintendence of the municipal authorities; or of special commissioners prescribed by acts of parliament, and chosen from among the inhabitants of the parishes, towns, or counties to which the control of the water communications may belong.

We will endeavour to give an idea of the progress of the British legislation with regard to water conveyance.

Before the creation of artificial means of internal navigation, endeavours were made to turn to the best account the currents of water which nature offers. It was found necessary to prevent private industry from appropriating these currents of water to its own uses, and thereby depriving trade of the advantages to be derived from them.

The importance of these measures was so forcibly felt in England, even at that period when the nations of Europe had scarcely emerged from a state of barbarism, that, so early as the 13th century, the English inserted, among the provisions of Magna Charta, a clause expressly ordaining that the course of the Thames and of all rivers should be duty free, and that all obstructions should be removed from them. (Chap. xvi.)

With the view of putting in force this wise provision of Magna Charta, an act of parliament, passed in the reign of Edward III. (in the year 1351,) directed the demolition of the dams of every kind which had been raised since the promulgation of the fundamental law, and which threatened inundations, or tended to impede navigation. The dams were to be destroyed without any indemnity being granted to the individuals who had raised them to the detriment of the public. This provision, wise as it was, ran directly counter to many private and powerful interests, and in consequence it appears never to have been completely carried into effect; however, at the expiration of twenty years, on the serious complaints which were addressed to the king by the Lords and Commons, an act of parliament removed this salutary regulation, and ordained that a fine of

100 marks should be paid to the King by any individual convicted of having, by dams or weirs, injured the lands in the neighbourhood of any river, or rendered the current of water less navigable.

If private interest could successfully contend with public interest in a glorious and powerful reign like that of Edward III., it may well be conceived that during the period of weakness and anarchy which succeeded that remarkable epoch of the middle age, the interest of individuals was sufficiently powerful to break through all the barriers of the law. This fact is obvious with reference to the subject to which we are now alluding, from ch. 6 of the statute of Edward IV., (1472.) This act briefly describes the measures which had been previously adopted with regard to water conveyance, the violations which those measures had undergone, and the evils which had ensued to trade and agriculture. To impart additional force to these measures, the above-mentioned act condemns any individual who may impede the execution of the regulations alluded to, to a fine of 100 marks, 50 of which are to be paid to the party who may prosecute, and obtain the conviction of the offender.

Independently of the general superintendence which belonged to the private interest of each citizen, county officers, distinguished by the name of commissioners of sewers, were intrusted with the management of rivers, either for the purpose of drainage, or for regulating internal navigation, for removing every obstruction from currents of water fit for the navigation of boats or ships, and finally for directing all the works necessary for the repair of injuries produced by inundations or accidents.

In 1427, the 6th Henry VI. ch. 5, established the forms according to which these commissions were to be instituted. This important act presents a complete system for water conveyance.

The 23d Henry VIII., ch. 5, renders permanent the temporary measures of the act of Henry VI. It empowers the chancellor to appoint commissioners to superintend the repairs of all damage occasioned to dykes, bridges, roads, and to the beds of natural or artificial currents of water, by floods or accidents of navigation. To the commissioners it reserves—1st, the right of constructing any works of art, and of destroying any ponds, dams, or even mills which they may think necessary for the purposes of navigation, or for reclaiming lands; 2d, the right of instituting inquiries or actions at law on account of detriment occasioned to any water conveyance; 3d, the power of fixing the amount of the indemnities or fines, according to the damage sustained or caused, and of levying taxes on property for the execution of the works from which that property will derive advantage. The law enjoins perfect equality in this territorial tax, without exception or diminution in favour of the clergy, the nobility, or the king.

Any individual who may neglect or refuse to pay his portion of the tax, is liable to confiscation or fines, *according to the good discretion of the commissioners*, as the act which institutes them expresses. If any one refuse to pay the tax appropriated to the expense of drainage, *&c.*, the commissioners may seize his land, and let it at a life rent, or merely for a term of years. They may put in requisition the oxen, horses, waggons, and workmen necessary for the execution of the works, by paying suitable wages or indemnities. They are authorized to take the wood necessary for the works, by paying for it *according to their own estimate of its value*.

They are empowered to make the necessary regulations for the police, and for the support of the water conveyance. They appoint watchmen, bailiffs, collectors, treasurers, and superintendents of works for collecting and laying out their funds, as well as superintending the employment of these funds. All these individuals are accountable to the commissioners, by whom their salaries are fixed.

Thus it will be seen, that the commissioners are invested at once with judicial and executive power. Before they enter upon their functions, they must swear to discharge them with impartiality, independence, and moderation, exerting their utmost endeavours to establish and keep in force equitable and wise laws, decrees, ordinances, *&c.* They must swear that they are possessed of a clear annual income equal to 40 marks, or that they possess landed property to the value of 100*l.*, or that they are freemen of a city or an incorporated town or borough, or that they are members of one of the four principal inns of courts. Any individual who may violate one of these conditions, is fined 40*l.* for every occasion on which he exercises his functions: one half of this fine is paid to the king, and the other to the informer.

The commissioners, as well as their secretaries, receive for every day which they devote to the duty of their offices, an allowance raised from the produce of the fines.

When a seizure is made by order of the commissioners, the party on whom it is made may prosecute the agent of the commissioners by whom the order was executed. A jury then decides upon the question according to the law of the land. If the agent of the commissioners should gain his cause, he receives as an indemnity the *triple* amount of the expense of the action and of the damage to which he has been unjustly subjected.

The commissioners are appointed for three years; and the regulations which they institute last only during a period equal to that of their appointment. According to the spirit of the British legislature, any citizen who may refuse to fulfil the functions of commissioner of sewers is liable to a penalty; in the same manner as those who refuse to discharge the gratuitous duties of surveyors of open roads are punishable. But no citizen can be compelled to exercise these functions in any except his own county. This is a highly just and reasonable regulation, since every landed proprietor must be supposed to feel particularly interested in the good condition of the district in which he himself resides. Besides, an individual may serve the public interest in the vicinity of his own residence, with more judgment and assiduity, and less sacrifice of time, than if he were called for that purpose to distant parts.

Such is the general system of legislation relative to water conveyance in England. There are special laws for the superintendence and management of certain currents of water, natural or artificial.

Thus, in the reign of Henry VI., in the year 1423, parliament appointed a committee to examine the defects in the course of the river Lee, which falls into the Thames, and to render it more fit for navigation. This committee was composed of persons of rank, who neglected the duties assigned to them. Consequently in the following year, parliament authorized the lord chancellor to select a committee from among the private inhabitants of the parishes adjacent to the Lee, who, as the act of parliament expressed, would be better able to correct the defects of the river, by the execution of proper works, and by the removal or alteration of those works which tended to impede navigation; 3d Henry VI., ch. 5.

The Thames is subject to a system of management, on a much more important scale. The lord mayor and corporation of the city of London are the conservators of the Thames, and have the control of all that regards the safety and facility of navigation, from the mouth of the river to as high as flood-tide extends. Throughout the whole of this extent, the conservators exercise a similar inspection over all stagnant waters and currents which communicate with the Thames*. 4th Henry VII., ch. 15.

The 27th of Henry VIII., ch. 18, grants to the city of London one half of the fines exacted from persons who may damage the banks of the Thames, or injure its bed by ballasting or filling up.

The act passed in the 21st year of the reign of James I. for rendering the Thames navigable from Oxford to London, is worthy the utmost attention.

In a very remarkable preamble, it is stated as the grounds of this act, that the works for thus rendering the Thames navigable have for their object—1st, to diminish the price of fuel and other articles of the first necessity, in the city of Oxford; 2d, to facilitate the conveyance of the produce of Oxford and the adjacent country to London; 3d, to save the high roads leading from Oxford and its vicinity to the capital, which roads were during the winter so broken up as to be extremely dangerous to travellers, and could not be kept in a passable state without enormous expense! Such was two centuries ago the condition of the public roads in England. Notwithstanding the limited extent of trade at that period, and the scanty population of towns, means were wanting for keeping the roads in proper order: it may also be observed, at the time here alluded to, there were no turnpikes.

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* By the 13th Elizabeth, ch. 18, parliament conceded to the corporation of London the right of rendering the river Lee navigable, from Ware to the Thames.

The act, which was founded on these grounds, consigned the superintendence of the works of the Thames to eight commissioners, four of whom were to be appointed from among the members of the University, and four from among the inhabitants of Oxford. The choice was left to the corporation.

During the civil war in England, but little progress was made in inland navigation. Many works of improvement which had been executed during the long and peaceful reigns of Henry VIII., Elizabeth, and James I., were, at this period, damaged, destroyed, or neglected. Under Cromwell, order began to be restored; and the works for improving the condition of the interior of the country resumed their activity. But it was not until the return of Charles II. that river navigation experienced any sensible advancement. Charles II. and his emigrant partisans, had, during their residence in Holland, been struck with the great advantages of inland navigation; and thus from the moment of their return to England we can trace the revival of this branch of public prosperity. One circumstance worthy of remark is, that at the period here alluded to, all the bills which were discussed in parliament on this subject had their origin in the House of Lords.

In the years 1661 and 62, the House of Peers attempted, but in vain, to introduce a general act for rendering navigable all currents of water, capable of answering the purposes of navigation. Several bills were however passed for ameliorating the navigation of different rivers, as for example, the Stour, the Salwarp, the Wye, the Witham, *&c.*

In the reign of William III. new acts added considerably to the improvement of the navigation of other rivers; these improvements continued during the reigns of Anne, George I., and particularly George II.

The general spirit of these acts was to consign to commissioners the management of the disputes that might arise out of the undertaking of river works. The expense of these works was defrayed by loans, which loans were afterwards paid by tolls. The laws on this subject are the same as those which apply to the artificial currents of water; we shall therefore refer the reader to the chapters in which we examine the regulations relative to canals.

Parliament has, by the adoption of rigid measures, provided for the conservation of the works of art necessary for water conveyance. By the acts 1st Geo. II., c. 2, 19, § 2, and 8th Geo. II., c. 20,

§ 1 [*], the law declares to be felony and punishable by death, the malicious destruction of any lock or weir established by authority of an act of parliament for inland navigation. The punishment of death is also inflicted on any one who may attempt to deliver, by force, an offender *legally* imprisoned for such a crime. The law punishes with one month's imprisonment and hard labour, the offence of maliciously opening flood-gates, or removing palings from a conduit, 8th Geo. II., c. 20.

The inhabitants of the hundred in which the offence has been committed are responsible for it, and if the offender be unknown, they must make good the damage, the expense of which, however, they may recover on the discovery of the offender. This is an excellent law, which it would be well to introduce into the regulations respecting our public works.

Water conveyance in Towns.

After the great fire of London in 1665, an act of parliament prescribed the measures to be adopted for re-building the city with regularity.

This act empowered the lord mayor and aldermen of London, to determine the number and the situation of the water-pipes in the city and its environs; a power which, as we have already remarked in chap. I., book I., is exercised by commissioners who are appointed by the corporation.

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[*] This provision was rendered permanent by a subsequent act.

These commissioners are authorized to levy a tax on the inhabitants, to defray the expense of executing and supporting the works which they direct. Their powers are as extensive as those of the commissioners of sewers in the counties. Their jurisdiction extends over all currents of water, natural or artificial, which fall into the Thames, within the distance of about one mile and a half above or below the capital.

Aqueducts.

In the 3d year of the reign of James I., an act of parliament granted to the corporation and citizens of London, the privilege of undertaking and executing an aqueduct, called the *New River*, which was brought from two springs at Chadwell and Amwell to the capital. By this act, the corporation was empowered to purchase the ground necessary for rendering the aqueduct ten feet in width; and they were moreover authorized to visit and inspect the banks of the river at all times, and to send thither the workmen, horses, and carts necessary for executing or repairing the works.

In cases in which the purchases of ground could not be amicably adjusted, commissioners appointed by the lord chancellor were authorized to fix the indemnities to be paid to the individuals who had sustained damage by having their ground occupied, the course of their waters turned, their mills rendered unfit for use, or diminished in value, *&c.* Of these commissioners, four were chosen out of the city of London, and four from each of the counties of Middlesex, Essex, and Hertford, through which the New River runs. They were to be possessed of landed property to the value of at least 40*l.* per annum, and were to form a quorum.

The corporation of the city of London could not take possession of the ground through which the canal was to be cut, until after having determined the price to be paid for it, either by amicable adjustment, or by the arbitration of the commissioners, appointed in the manner above described. If the owners of the ground were not paid according to the arbitration, they might prosecute the corporation in any of the courts of Westminster-hall. The corporation were bound to repair, at their own expense, all overflowings of the canal, and the damage that might ensure therefrom.

The New River being completed, is like all currents, whether natural or artificial, under the jurisdiction of the commissioners of sewers, in all that regards the management of the water. But the corporation of the city of London directs the works; and superintends, for the support of these works, the application of the funds, raised by the fines which are incurred through the violation of the police regulations to be observed along the canal.

In the year succeeding the grant for undertaking the New River, another act authorized the establishment of a second aqueduct, for conveying to London a part of the water of the Lee. The secondary object of this enterprise was to supply water to the western parts of London and Westminster. The principal object was to add to the endowment of a protestant Sorbonne which king James I., proposed founding at Chelsea, on the site now occupied by the hospital. Commissioners were also appointed for this canal, to proceed by arbitration in estimating the value of lands between the owners and the individuals engaged in the enterprise.

Supply of Water for Aqueducts.

The conditions attached to the supply of water are equally important to the companies whose business is to supply towns, and to persons engaged in navigation, who, whenever the current is made to branch off in any new direction, lose a portion of their means of conveyance. In consequence, the legislature has determined these conditions with the utmost attention. For example, we will describe the principal measures adopted in the reign of Geo. II., in the year 1739, for regulating the supply of water for the New River.

The trustees of the navigation of the river Lee were empowered to establish a dam for collecting water between the bridge of Ware and the town of Hertford. The opening and closing of the dam, as well as its support, afterwards came under the superintendence of the New River Company.

The water was to be collected on a spot specified by the act of parliament, through a narrow cut, the dimensions of which were determined. This cut, the height of which was also fixed, served as a guage for the water. It was six feet in breadth, and two in height. It was constructed of wood along the twelve first feet of its length, and was to be continued in brick-work, wood, or stone; but without any variation in its width or height. The company were prohibited from obtaining any other supply of water from the Lee.

To prevent the commissioners from collecting more water than they were permitted to do, they were required to keep in good condition, at their own expense, 1st, the bed of the river in the parts adjoining the cut; 2d, the dam, and the apertures for discharging the water, so that its upper surface above the dam migh never rise beyond the height fixed at the upper limit of the collected mass of water.

A machine called a balance engine was employed for ascertaining precisely the height of the water. This balance was surmounted by a structure which is kept by a person in the employment of the company. The trustees of the navigation of the river Lee were entitled to inspect as often as they pleased the engine balance, and the different works for forming the collection of water, in order to ascertain that all were in good order, and conformable with the stipulated conditions.

The company were declared proprietors of the water conceded to them. All persons were forbidden to throw into the currents communicating with the New River, or into the river itself, or any of its branches, any kind of rubbish, stones, filth, dead animals, animal substances, *&c.* It was declared unlawful to wash in the river wool, hemp, flax, or any other foul or unwholesome substance; to turn aside or impede the current, or take water from the river without the express consent of the company; or finally to commit any damage upon the works of the New River or its dependencies.

The New River Company were authorized to prosecute all persons who might commit any of the offences or damages above mentioned.

The commissioners appointed to superintend the enforcement of the act, were, 1st, the lord mayor, the aldermen, and the recorder of London; 2nd, the members of parliament for London and Westminster, and for Middlesex, Essex, and Hertford, through which counties the Lee River runs; 3d, the mayor of Hertford, &c. Ten was fixed upon as the smallest number of the members of the committee necessary for forming a *quorum.* The trustees were to meet annually on the 6th of August in London, or in one of the three counties abovementioned, to adopt the necessary measures for the discharge of their functions.

It was the business of the commissioners to ascertain that the sums borrowed by the company were punctually repaid; and that the works for collecting the water were carefully kept in order, according to the dimensions and forms prescribed by law, &c.

CHAPTER II.

Preliminary Considerations on the Formation and Management of Canals in England and France.

WHAT is the best plan for the formation, management, and preservation of canals? Should the execution and possession of these great public works belong to the government, or should they be intrusted to private industry?—These are questions of the highest interest; and, at the present moment, it is particularly important that they should be resolved by the *evidence of facts;* so that the zeal and attention of our ministry and legislative chambers may be directed to those measures which are most favourable to the internal prosperity of France.

Common sense must convince us, that by engaging numerous fortunes and interests in the execution of works of public utility, the combined efforts of a multitude of private individuals must produce results superior to the single exertion of the most powerful and wealthy administration. A government has such numerous and various demands to satisfy; it has so many losses to repair during peace, and so many sacrifices to make at every other time; it is so burdened by expenses which relate to personal interests, that it is ever inclined to retrench the first expenses devoted to those national interests which do not so urgently speak for themselves.

These causes have operated more powerfully in France than in any other country. Hence the numerous public works which have been begun during one reign, and have been relinquished during the next; undertaken by one set of ministers, and destroyed by those who next came into power*. But when personal interest finds its advantage in erecting and preserving works, which are the more profitable in proportion as their utility is the more extended and permanent, the public benefit is guaranteed by the most durable of human passions, self-interest; and this public benefit is served at all times and in all circumstances,—in war as well as in peace,—during the prosperity as well as in the poverty of the state treasury.

I shall frequently have occasion to recur to these topics, to which I have already adverted in the introduction to the present part of my travels. I feel it to be my duty to dwell on these points, convinced as I am of the necessity of continually setting forward the same facts, in order to bring obstinate minds to attend to the counsel which is most to their advantage; particularly when this counsel runs counter to inveterate prejudices and long established customs.

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* The canal of Briare, which was begun in the reign of Henry IV., was abandoned on the death of that great monarch, until near the close of the reign of Louis XIII., when it was determined to consign it to the management of a company, by whom it was finished in less than four years. As to other works of the same kind which were undertaken by the state at subsequent periods, some have lingered in their execution in a manner most ruinous to the public treasury and the persons engaged in them; others still remain unfinished, so that the capitals which have been sunk upon them have been hitherto lost to the country.

On the subject to which we are now directing attention, the results of experience correspond with the consequences deduced from speculative reflections, and also with the demonstrations of profound reasoning. The canals of England, which as well as the roads in that country, are executed in a manner so conducive to individual and public advantage, owe their existence, for the most part, to private associations. The British ministry not only permits the execution of public works by means of private associations; but it even presses forward to meet the zeal and resources of private industry with the aid of public credit.

In the *examination of the system of the British administration, for* 1822, we have pointed out the advantage of the course pursued by the English, by explaining their means of improving their finances and promoting internal prosperity:—"The fourth measure adopted for giving increased activity to the circulation of money was to grant the loan of the sum of two millions sterling, in exchequer bills, to aid the execution of public works by private companies. The British ministry regards the utility, and even the necessity of such a measure, as a fact universally acknowledged in England. It is notorious, says the historian of that ministry, that the reduction of the national expenses has thrown a great number of persons out of employment. Agriculture and manufactures, in their present condition, are not sufficient for restoring to activity the surplus of labourers. The government cannot relieve the distress of the unemployed, except by affording them occupation in the execution of works of public utility. If the government be unable to give, it is still able to lend. It may, without the risk of loss, lend large sums, either for longer periods, or at a lower rate of interest than private individuals can do, because it can *itself* borrow on more advantageous terms, by means of the superiority and extent of its credit.

"What a vast difference is there between the systems pursued by the English and French governments with regard to public works! The former grants loans to the public at an interest of 3 per cent., to enable them to execute themselves works which are useful to society. The latter borrows from the public, at six, seven, and seven and a half per cent., for the execution of works which that government *alone* conceives must be useful to the people.

"I venture to affirm, that the mode pursued by the British government is the most advantageous, This assertion is founded on the testimony of men of the most weighty authority in the most opposite political parties. I refer to the speeches of MM. de Villèle, de la Bourdonnaye, Foy, and Girardin; to the administrative papers of MM. Fiévée and Laborde; and to the technical works of MM. Huerne de Pommeuse*, Dutens†, and Cordier‡. All acknowledge the great advantage of leaving works of public utility to be executed by the public themselves.

"We are aware that temporary causes and fortuitous circumstances may have compelled the French government to take upon itself the execution of works of public utility, by means of loans contracted with private individuals. We are far from entertaining a doubt on this point. But, for the welfare of France, we sincerely hope that such circumstances and causes may never again return.

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* In his *Treatise on Navigable Canals*, M. Huerne may claim the honour of having been among the first of those who called the attention of the legislative power and the government, to the important subject of canal navigation.

† M. Dutens, in his *Memorials on the public Works of England*, has furnished some excellent remarks on the subject of canals, as well as on bridges and roads.

‡ See the introduction to his *History of Inland Navigation.* We shall in the present chapter repeat some of the remarks which we made in the *Revue Encyclopedique*, for May, 1819, in rendering an account of M. Cordier's work, which reflects honour on the patriotism, as well as on the judgment of the author.

This is a point which materially and positively interests all Frenchmen, whatever may be their opinions or their political stations.

"The important results obtained by a rival nation must operate as a powerful stimulus to induce us to pursue a course by which we should be enabled to procure still greater results; and which will raise us to the highest eminence with regard to the execution, management, and improvement of works of general utility to trade, manufactures, agriculture, and navigation." *Examination of the British System of Administration*, in 1822.

In the introduction to this part of our travels, we have remarked that French monarchs have set an example to Europe on the subject of the formation of canals, and a just system of arbitration with respect to the property interested in these works. In a province constitutionally governed, like that which was known under the name of Languedoc, so celebrated for the beauty of its public works, the commercial and advantageous system of intrusting the execution of canals to individuals was able to be successfully applied. This system can only exist where liberty and property are respected. Thus, an important example of the good effects of this method is presented by the canal of Languedoc, which has so greatly augmented the prosperity of the south of France.

This canal has entitled Louis XIV. to the gratitude of all Europe. Foreign engineers (among others, Phillips in his *History of Inland Navigation*) candidly avow, that the well-merited celebrity of this admirable monument called the attention of the sovereigns of other countries to the internal navigation of their states.

The great works executed during the reigns of Louis XIII. and Louis XIV., presented examples which did not remain without imitation in France. To the exertions of companies we have been indebted for the canals of Loing, Orleans, Picardy, Beaucaire, the Deule, the Lys, the Fontinettes, *&c.* If such enterprises could originate and prosper under an absolute government, when private interest was so ill able to contend against the despotism of the agents of power; what success may not be expected from the adoption of the same system under a constitutional government, which affords to every citizen, represented in the chambers, the sacred right of petition, and under which, thanks to the freedom of the senate and the press, every individual finds generous defenders, eager to demand justice in his behalf.

But ere we can look forward to the attainment of important results, we must break the numberless chains which the governments of the consulate and of the empire have bound on the members and the body of the state*.

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* On this subject we cannot do better than once more refer the reader to the works of MM. Laborde and Cordier. The latter, in treating more particularly of the subject which at present claims

Since the year 1800, when all powers were concentrated in Paris, the departmental and municipal administrations have not possessed the right of making the least essential decision. Not only in undertaking new works of inferior and wholly local importance, but even in making the most trivial repairs, it is necessary to draw up plans and estimates, to address them to the ministry, to wait for a tardy approval, to seek for a contractor, to treat with him, and finally to get the tender and the contract settled. What are the consequences of these long and numerous delays? Increasing decay of the public works; expenses augmented beyond the possibility of being defrayed. Then ensued the ruin of bridges and locks, the total suspension of navigation and trade, the diminution of the revenue of canals; and, finally, the scanty revenue arising from them became totally inadequate to cover expenses which might have been easily avoided. All these evils would be obviated by consigning to private companies the formation, the support, and the emoluments arising from canals.

Do we regret the alienation, in favour of a few in-

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our attention, courageously attacks the terrible chaos of laws and decrees transmitted to us by ten successive governments, all of which have been raised out of the ruins, while each has been indebted for its existence to the ignorance, despotism, and injustice of the one that preceded it. M. Cordier also shews how the engineers of roads and bridges might be employed more actively, and in a way more advantageous to themselves and the public, in planning and directing works executed by companies.

dividuals, of property which may be rendered free and gratuitous to all? We may adopt a system which has often been pursued in England, with regard to the construction of bridges; namely, to grant permission for the levying of a toll, which must cease, when all expenses being paid, the surplus of the revenue, *lodged in the public funds*, shall have produced a capital, the interest of which is sufficient for the support of the works.

M. Cordier argues powerfully against the impediments which military authority raises against all plans of navigation in the numerous departments which form the territory of France. The following is an analysis of his ideas on this important subject.

When the engineer in chief of any frontier department draws up a plan for a road, a bridge, a canal, a lock, *&c.*, he must first send this plan to the colonel of military engineers, whose direction is in the district where the proposed works must be executed. But as there is no connexion between the departmental division and that of the military stations, the same colonel of engineers is frequently obliged to discuss a plan with the engineers of the bridges and causeways of two or three different departments; and reciprocally an engineer of bridges and causeways is forced to defend his plan in opposition to two or three directors of fortifications. Now these officers, who are perfectly independent of each other, taking their grounds according to their own respective powers, and judging according to their own particular knowledge, scarcely ever come to an understanding together. The matter is referred, according to custom, to a committee at Paris. Then arises the conflict of different pretensions; and without any acquaintance with the situation or localities, an irrevocable decision is pronounced on a plan which has been the result of deep consideration, and in which the author, by attentive calculation has endeavoured to surmount the difficulties which the projected site may present.

These inconveniences are felt at all times, because they depend on permanent institutions. In times of war and trouble there is another scourge which assails our public works; it is an evil which can never exercise such an influence in England; this evil is the poverty of the treasury. In most nations war interrupts, or at least delays the execution of works of general utility, the expense of which cannot be defrayed by a treasury overwhelmed with debt; but in Great Britain, war, by the activity which constitutes its essence, imparts a new impulse to public works. By consigning these works to the enterprising spirit and the activity of individuals, the British government substitutes for the temporary efforts which it might be enabled to make by a superfluity of taxes, the permanent efforts of the public at large, in furtherance of their own interests, of which they are well qualified to judge. Thus from 1790 to 1805, an interval which included four years of peace and eleven years of war, upwards of 1500 miles of canals were cut in England alone. This is about one half of the total length of the canals which have been undertaken within the period of 60 years.

How different was the progress of our public works during the same period. In the long and peaceful reigns of Louis XV. and Louis XVI., numerous works of general utility were undertaken, some by the government, and others by provinces, cities, and companies. The revolution broke out—the rights of property were violated—these works were declared to be the property of the state; they were taken from their lawful possessors, their revenues were consumed, and their repairs wholly neglected. These sources of wealth, so shamefully usurped, were soon exhausted; and then ensued the stagnation of many branches of trade and the ruin of whole districts. It is gratifying to be enabled to add that a succeeding government has exerted all its efforts to obliterate every trace of these mischiefs.

Without stopping to advert to the period when the ruin of private fortunes and the immense burdens incurred by the national defence, exhausted all the resources which might have been applied to public works useful to trade, we will confine our remarks to a period of peace and prosperity. Since the close of the war, during the most flourishing state of our finances, government has not been able to devote to public works, more than the annual sum of thirty-one millions of francs, which is insufficient even for their support. To commence new canals, or to complete those already begun, government has contracted a loan to a large amount, the interest of which is to be paid until the final reimbursement of the capital. What then can be done in time of war, particularly if the conflict be prolonged; if reverses be mingled with success, and great sacrifices be required? The necessity of economizing the money appropriated to useful enterprises in the interior, will lead to the retrenchment of the moderate sum destined for bridges and causeways. These works will fall into decay, and their decay must necessarily augment the difficulties in which our trade and manufactures will already be involved. All these evils would be adverted by gradually intrusting public works to the management of companies, who, in time of war, as well as during peace, would naturally direct their efforts and their attention to the preservation of those objects from which they obtain emolument.

Having endeavoured to point out the advantages which a government and society in general derive from the plan of consigning public works to companies, we will make a few remarks on the benefits which this system secures to individuals. In England it is remarkable how many persons present themselves as subscribers to any new canal. Their number frequently amounts to more than 200; and yet the majority are not capitalists. The proprietors of ground, of mines, or of manufactures, in the vicinity of the course of the projected canal, calculate, in the first place, according to the outlets presented to them, the more extended sale and the increased value of their agricultural and manufacturing produce; advantages which indeed are far superior to the profit most of them will derive from their shares in the proposed canal. This is a happy spirit of foresight and calculation with which it is necessary to inspire our landowners, proprietors of manufactories, *&c.*

In France it is complained that fortunes are too small; and it is believed that in England all the laws tend to favour large property. But, with respect to the subject at present under consideration, the English laws have, on the contrary, done every thing to favour small property. Any individual possessing a capital equivalent to 100*l.* may not only become a shareholder in a bridge, a canal, or a dock, but if he possess only the half, the fourth, or even the eighth of this small capital, he may still become the owner of a portion of any of these works. This excellent law seems to be admirably well calculated for France: in adopting it, however, we must be careful to proportion the price of shares to the moderate amount of our fortunes, and also to the difference in the value of money, which is greater in France than in England: for example, 300 or even 200 francs might be sufficient to enable an individual to become a member of a company of any public work—we might form companies of 500

1000, or 2000 small capitalists, or even a greater number if it were deemed necessary. For this kind of speculation we might have our *petit-grand-livre*, as we have our *grand-livre* for property in the public funds; by this means we should interest large, middling, and small fortunes in the good construction and proper support of our public works necessary for commercial transport.

In the present state of things, when it is proposed to purchase ground for the execution of public works undertaken by the government, it is justly complained, that the arbiters appointed to value these grounds raise their estimates to the most extravagant amount. The prevailing idea seems to be that a sum wrested from the treasury is always *so much advantage gained over the enemy. (Autant de pris sur l'ennemi.)* If public works of general utility become the patrimony of citizens; if landed proprietors and capitalists, or their connexions, become chiefly interested in these works, the extravagance of these estimates by favour, will be found far less natural and just; and public opinion would itself correct the evil which it now contributes to keep up.

The system of establishing canals, by permission granted to companies, has been opposed by sophisms, which it is essential to refute for the interest of our country and our government. It has been affirmed, that in France, there are too few companies capable of undertaking great canals; that the utility of these enterprises is not generally enough understood; that it would be difficult to foresee how far such speculations would be profitable, *&c.*

Doubtless, if it be determined to treat only with opulent shareholders, very few companies will be found, because the number of great capitalists is extremely limited in France. But if it be wished to place shares within the reach of persons of the most moderate fortune, companies will soon be established; and they will be as numerous and as rich on the whole, as the most ardent promoters of French industry can desire.

Instead of asserting as a fact the present incapacity of French speculators, (an assertion which we positively deny), would it not be better to furnish them with the means of acquiring information, and of enabling them to take an accurate and enlarged view of their own interests, combined with the interests of the public.

Though many opportunities of improving the information of the industrious classes have already been suffered to escape, government may yet render immense service to the people, by inviting the principal landowners in the districts through which canals are to be cut, to meet for the purpose of discussing together the advantages of these useful works. Other meetings might also take place on the invitation of the public authorities, at which the most distinguished merchants and manufacturers might develop, under a new point of view, the respective advantages of landed or manufactured property, and of neighbouring or distant trade. Finally, the estimates of expenses, drawn up by the engineers of roads and bridges, would at once enable landowners, merchants, manufacturers and capitalists to balance, on the one hand, the expenses at the *maximum* of valuation; and, on the other, the receipts and profits at the *minimum* of their supposed produce. The results of these investigations and deliberations would be published in all places; and the best tribute of praise to works of merit would be the shrewdness of the views, and the accuracy of the calculations, to which they might give rise. The mass of the people would place full confidence in the estimates made by a select portion of the public; and subscribers would not be wanting for enterprises, the public and private advantage of which would be proved by the suffrages of the wealthiest and best informed portion of the landowners and manufacturers.

By this means, many individuals would be enabled to improve their fortunes; and the spirit of calculation and association, which would be diffused among the thinking portion of the public, would shew the advantages to be derived by each individual from works of general utility; would accustom men to communicate to each other their observations, views, and plans; and would guide their judgment by the information derived from discussion. Meetings thus formed for the sole purpose of deliberating on commercial interests could not give umbrage, even to the most suspicious government. They would present none of the objections that may be urged against meetings, which, without any legal authority, are held for the purpose of discussing political questions; while, at the same time, they would present all the advantages of political meetings, by encouraging reflection and discussion, and teaching men to develope their ideas with clearness and facility. Every one would be enabled to form an opinion of the merits of those individuals, who, stimulated by zeal and talent, wish to come forward and gain by real services the approbation of their countrymen.

When our electoral assemblies afterwards came to nominate individuals to support our most important interests, public favour would already be fixed on those men who might have distinguished themselves for superior intelligence, uprightness of conduct in the management of local affairs, maturity of experience and judgment, and the valuable advantage of being able to present just ideas and elevated views, in an easy, clear, and powerful manner. The public choice, instead of being the effect of chance and caprice, or the result of unfounded celebrity,—the reward of the mere talent for talking, or ignorant assurance—would be the recompense of services already rendered, and the stimulus for performing new ones.

I must beg forgiveness for having thus long dwelt on the affairs of France, in a work which professes to treat of England only. I am not, however, departing from my subject, when I speak of the direct interest of any country. It is by a secondary consequence of this interest, that I seek to examine how far our rivals, who at first slowly followed our footsteps, have got the start of us, and have left us to endeavour to outstrip them in our turn. I study and describe what foreigners have done, as though I were speaking of future France.

CHAPTER III.

The Undertaking and Management of Canals.

In Great Britain, as we have before observed, the canals, roads, and bridges, are generally executed and managed by private persons; sometimes even by a single individual. The few works of this nature which government have undertaken at their own expense, have been by way of exception, and for reasons of state.

In thus intrusting to the citizens these undertakings of general utility, the legislature has, however, reserved to itself the privilege of granting the previous sanction; to obtain which, it is necessary to adopt certain formalities. These, though very important, have never yet been described in any work relating to England. At my request, Mr. Telford, a celebrated engineer, to whose public services I have already alluded, in speaking of the roads of Wales and Scotland, and whose excellent works I shall frequently have occasion to mention, has been good enough to draw up an abstract of all the formalities observed in the establishment of companies who undertake the execution of public works useful to trade. I need only repeat a statement traced by so able a hand.

I. If any individual should conceive that the construction of a new canal, a bridge, or a road, would be advantageous to the interests of the county in which he resides, he communicates his views to other persons, who assemble to consult on the subject. If the idea be approved, a plan of association is drawn up, and submitted to those individuals who possess the greatest influence in the county, and who would consequently feel most interested in the execution of the projected work. If the plan be approved, a general meeting of the persons who are most immediately interested in it is convoked. The object of this meeting, which is advertised in the public papers, is to discuss publicly the proposed undertaking; which is abandoned, if the majority should decide against it. If, on the contrary, the majority declare themselves in favour of the plan, a subscription is opened to meet the preliminary expenses. A preparatory committee is appointed, whose immediate office is to direct the execution of the plans, to calculate the expenses, and to draw up the necessary reports.

II. For these purposes, the preparatory committee immediately employs surveyors and engineers, whose report, together with the evidence on which they are founded, are laid before the second general meeting of the subscribers. These plans being discussed, and definitively approved, the committee pursues its labours. In cases where a work of great magnitude is to be undertaken, it is sometimes thought proper to employ several engineers in competition. Their plans are compared, and that which seems best is selected from the others. Of course, the expenses are augmented in proportion to the number of plans that are executed; but it is obvious that great benefit must be obtained from the emulation thus excited among men of talent, who, on such occasions, exert every endeavour to raise their reputation, or at least not to allow themselves to be lowered in the public esteem.

III. As soon as a plan is decided on, the preparatory committee directs the surveyors and the engineers to execute several copies of it, together with sections of the projected works, and of the lands through which they are to be carried. These are to be accompanied by a list of the counties, parishes, towns, and villages, and of the proprietors and tenants of each estate and dwelling-house, the possession or convenience of which may be affected by the plan. A duplicate of this list, which is divided into three columns, marked with the words, *assenting*, *dissenting*, and *neutral*, is forwarded to each proprietor, who signs his name in which column he pleases. Previously to making any application to parliament, and on the 30th September, at the latest, a copy of the same list must be forwarded to the office of the justices of the peace of each county, within which any part of the proposed works will be included.

The direction and situation of the road, canal, or bridge, are announced in the London Gazette, and in one of the newspapers of each county in which the intended work is to be executed. This announcement is also placarded on the door of the court of justice, during the sitting of the autumn assizes in the same counties.

IV. The preparatory committee, with the assistance of its engineer and law solicitor, makes a draught of the bill which is to be presented to parliament in the ensuing session. This draught is submitted to the general meeting of the subscribers. If it be approved, a petition is addressed to the House of Commons praying for its reception; which is not granted until the house has satisfied itself by means of a special committee, that the petitioners have in all respects observed the forms prescribed in its standing orders. These forms being fulfilled, the bill is received, and read for the first time. A certain number of days must elapse before the second reading of the bill, on which occasion every objection that can possibly be raised against it is set forth. The bill is frequently rejected on this first debate; but if not, it is referred to a special committee appointed to examine it clause by clause. Before this committee proceeds to the critical examination with which it is intrusted, a copy of the bill is sent to each county in which the line of works is included, and deposited in the office of the justice of the peace belonging to each of the parishes included in the plan, where it is open to the inspection of any person desirous of seeing it.

Meanwhile, the committee of the House of Commons meets to discuss the bill. The objections raised against it are sometimes of so serious a character, that it is found necessary to reject it. If, on the contrary, the bill be approved, the committee makes its report to the House of Commons. After the lapse of a few days, the house proceeds to the third reading of the bill; it is again discussed, and if it obtain the majority of votes it is passed. It is then carried to the House of Lords, where it goes through the same formalities of previous examination, readings, and debates. At each step of its advancement, it is liable to a final rejection. At length, if the peers approve it, and it receive the royal sanction, it becomes an act; it is a part of the law of the land.

The difficulties and objections which may be raised against every act introduced in this way, are so varied and so numerous, that it is not easy to give a distinct and complete idea of them. Some individuals found their opposition on their notions of the inutility of the project; others on the impossibility of obtaining a sufficient revenue to reimburse the expenses. Some are afraid that the new plan may be prejudicial to certain works already executed; others feel annoyed that the line of operations does not pass through places which would better accord, either with their ideas or their interests; or that it passes too near their residences, or intersects some of their enclosures or cultivated lands. Some oppose the plan, merely because it has originated among men whose political opinions differ from their own; and finally, there are some, and those in no small number, who reject the plan, simply because they are averse to new projects of every description.

The opponents of the bill first try their strength in the county meetings. If they fail in this way, they turn their views towards parliament, and endeavour to form a party there. To obtain this object, they frequently engage counsel, who are heard, not only before the committee, but at the bar of each house. On those occasions, sometimes the whole of the bill, and sometimes its weakest parts are attacked and discussed with considerable warmth. These debates not unfrequently last for months together; and it sometimes happens, that a bill which has been rejected in one session, is brought again before parliament in a succeeding one, and triumphantly passes. Such are the principal circumstances which attend these discussions.

As soon as the act of parliament is obtained, a general meeting of the subscribers, who are declared proprietors by the act, is convoked. All the operations which it will be necessary to adopt are then discussed. A managing committee of works, a secretary, a treasurer, an engineer, and all the other persons, whom it will be requisite to employ, are appointed and directed to commence their operations.

Correct and detailed plans are then prepared, and the works are parcelled out into divisions and subdivisions. The distribution of these lots is announced in the public papers; they are given to those who will undertake the works on the lowest terms. The tenders are sent in under a sealed cover. On the day named in the advertisement, the seals are publicly broken, and then, those individuals who do not offer sufficient securities, being withdrawn by the special deliberation of the managing committee; each lot is adjudged to the person who agrees to contract for it at the lowest price.

In forming these contracts it is stipulated, 1st, that the contractor shall personally assist in the execution of the works; 2d, that the operations shall be submitted to the superintendence of an inspector appointed by the committee; 3d, that such part of the works as may be completed shall be measured every month, when seven-eighths of the expense shall be paid without delay; the remaining eighth, bearing interest, lies in the hands of the managing committee, until such time as the terms of the contract shall have been duly fulfilled. On the definitive certificate of the engineer, the whole amount of the sums retained is paid off.

The contractor is required, before he commences his operations, or at least before he receives any payment, to furnish securities to a certain amount.

The works being completed, their support, the receipt and employment of the revenues they produce, and, in a word, all the interests of the company are superintended by a managing committee, whose operations are subject to the inspection of a general meeting, held every six or twelve months, as will be seen in the following chapter.

Such are the means by which the English have, for half a century back, executed a great number of works of immense utility; and these works have inspired the present generation with a taste, habit, and talent for the discussion of general affairs.

After a short time has elapsed, the management of the interests of a free company fall, as a matter of course, into the hands of a small number of the most active and experienced members. But as every member of the company has a right to partake in the discussions, and give his vote in the decisions, each preserves his influence and his importance; each becomes imbued with the general spirit of the society; each becomes better informed and more capable of rendering himself useful, than if he had never taken part in deliberative assemblies. By this means, as we have already remarked, individuals of all ranks acquire a knowledge of the character and talent of the most distinguished men; while mediocrity, being unable to conceal itself, is soon estimated as it deserves.

Thus the discussion of mere personal and limited interests, by qualifying men for the discussion of the great interests of a whole nation, raises them above the multitude, and marks them out as objects worthy of the esteem, confidence, and suffrage of their fellow citizens. We cannot too strongly or too frequently dwell on the advantages presented by meetings of companies engaged in works of public utility.

As to works which are executed at the expense of the state, they are regulated by act of parliament, and are subject to all the measures and discussions which have been mentioned in this chapter; only that the expense of their execution is voted out of the public revenue. The management of these works is intrusted to a committee, whose members are specified in the act of parliament, and who discharge their duties gratuitously. This committee in general consists of members of parliament, magistrates, and wealthy individuals who have some particular connexion with the district in which the works are to be executed. But whatever be the importance of these works, they form mere exceptions to the general custom of the British nation; where the execution and the improvement of works of public utility are best attended to, when they are consigned to the management and superintendence of private individuals.

CHAPTER IV.

Acts relative to Canals and Aqueducts.

These acts, like other laws of the British Parliament, are tediously long, and are drawn up without any regard to arrangement. In order to point out in a methodical and concise manner, the most remarkable provisions of these acts, we will successively examine all that relates to duties and powers, shareholders and their general meetings, the managing committee and its operations, the commissioners and the juries of arbitration, and finally, the purchase and sale of ground.

Duties and Powers.

The act which authorizes the establishment of a company explains, in the first place, the grounds of public utility on which it is passed—namely, facility of communication between important towns; economy in the conveyance of coal, manure, agricultural produce, *&c.*; the increased value which the new line of navigation will give to the property in its vicinity; and sometimes the necessity, or merely the advantage, of conveying supplies of water to towns, and particular places.

The act contains a list of the names of the members of the company, whom it declares to be perpetual proprietors of the canal. It authorizes them to make common stock of the funds required for the undertaking; to bring and defend actions in courts of law, as a corporate body; to purchase the ground over which the canal is to be carried; to execute the works which may be required for the new line of navigation, as well as for conveying water for the supply of certain towns.

Next come the details relative to these works. If it be necessary to cut through a road, or to render it impassable in any part, the company must, in the first place, make a new road as near as possible to the old one, and keep it in perfect repair. To establish communications between the canal and the neighbouring public roads, they must make new roads, and keep them in repair at their own expense.

The act of parliament determines the depth of the canal, and the height to which the water must rise. In certain situations it directs the construction of *off-lets* or waste channels*, to prevent the canal from receiving more water than the act permits.

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* When the millers are interested in collecting the surplus water, they choose a surveyor, who, acting in concurrence with the company's engineer, directs and superintends the execution of the off-let. If they cannot agree, they appoint, as an arbiter, a third engineer, who examines the off-let as often as he thinks fit, to see that it is kept in good repair, and in a state conformable with the provisions of the law.

If the projected canal be intended to supply any other aqueduct, the points from which the water is to be conveyed are also specified in the act of parliament.

The act determines, 1st, the general breadth of the canal with its towing path, and the ditch which runs along the side of that path; 2d, the width of the places where it is necessary to dig beyond a certain depth; also, the places where creeks and basins are to be formed for the convenience of the meeting and the turning of the boats, as well as for their being laid up.

The act also fixes the situation of the basins, quays, warehouses, and of every other establishment to be formed by the company, for the trade of the canal. Proprietors of the adjoining lands, provided they do not obstruct the towing path, and the navigation, may also dig creeks and basins for their own boats, throw bridges over the canal, make roads terminating on the line of the canal, and build on the same line quays and warehouses, furnished with engines for loading and unloading the boats. Neither the company nor the public can make use of those quays, warehouses, and engines, without the consent of the proprietors.

Works.

The company must make and keep in good repair, 1st, the pipes, gutters, and ditches necessary for carrying off, into the canal, or under it, the waters which might inundate the neighbouring grounds; 2nd, the watering-places which existed before the undertaking commenced, *&c.* In case of negligence in this respect, every farmer or proprietor who sustains damage, may apply for redress from the company. If the damage be not repaired at the end of three weeks, he may apply to five commissioners, who are arbiters, who will authorize him to make the repairs himself without further delay. These commissioners regulate the expense of the repairs and make the company pay it.

The company causes the ditches of the grounds adjoining the canal, to be cleared out at the expense of the proprietors or occupiers, who, for two months after having been summoned, have neglected to cleanse the said ditches themselves.

Shares.

The act of parliament fixes, 1st, the amount of the company's stock, and the amount of each share; 2nd, the *minimum* and the *maximum* of the shares, or portions of a share, which may be held by a single individual (except in the cases of marriage and inheritance.) The supernumerary shares fall to the profit of the company.

The law provides for the payment of the shares of a deceased partner, by his heirs; it indicates how the real proprietor is to be recognised in the case of transmission of property, occasioned by a change of civil condition, by bankruptcies, or by absence, &c.

Every partner may transfer his shares, when and to whom he pleases; but if he sell a share, without having paid the demands made upon him by the managing committee, it is forfeited to the profit of the company.

It is surprising that canal shares have not been made real property by the British legislature. In France they ought to be considered as landed property.

General Meetings.

These are the legislative assemblies of the company. They make local regulations called *by-laws.* They are usually held once a month, on a day, and at a place, advertised in the newspapers of the district through which the canal passes. They may adjourn on fixing a day, and place, for a new meeting. They decide by a majority; but it is necessary that the members present should exceed a certain number, which is fixed by law. At each meeting the shareholders choose a chairman, who has a casting vote when the opinions are equally divided. Every partner has one vote per share, if the whole number of his shares do not exceed a certain value. Finally, a shareholder may vote by proxy, provided the proxy be himself a shareholder; but the number of absentees, whom a proxy may represent, is limited.

The general meeting causes a list of the names to be made out, and transcribed in a register, according to the order and number of the shares. An extract from this register given by the secretary, and bearing the seal of the company, is legal evidence in courts of law. In order to give a purchaser a legal title as a shareholder, the seller must procure a regular entry of the transfer of his share on the register, for the interest and the dividends are only payable to the persons whose names are inscribed on the register. If a question arise with respect to the property of a share, each of the claimants appoints an arbiter, and a third is appointed by the secretary of the company. These arbiters determine whether the name of the old proprietor is to remain in the register, or the name of the claimant to be substituted in its stead.

The general meeting is empowered, for the purpose of completing the company's stock, to raise loans, by mortgage, on the property and revenue of the canal. The secretary of the company enters these loans in a book to which the persons interested have at all times free access. The creditors created by such loans cannot be considered as shareholders.

It is also by the general meeting that the managers, the secretaries, and the principal agents of the company, are appointed and dismissed; that the receipts, and expenses, are finally examined; that every person acting for the company may, at any moment, be called upon to give up his accounts; and that the necessary regulations are made for securing responsibility, for the management of the works, the superintendence of the navigation, and the penalties by which the company punishes infractions of the police regulation of the canal. These rules are printed; they are referred to as authority in courts of law, in so far as they are conformable to the laws of the realm, and particularly to the act for establishing the canal.

Managing Committee.

This is the executive power. An account of all its transactions must be given to the legislative power, that is to say, to the general meeting, which makes the laws by which its conduct must be guided, and which fixes the expenses of the administration.

The duties of manager are performed gratuitously; they cannot be intrusted to any agent of the company. The act of parliament fixes the *minimum* of the number of managers; their decisions are made by a majority of votes, a specific number of members being present; each member has only one vote, whatever be the amount of his shares. When there is an equal division of opinions the chairman has a second or a casting vote.

The committee appoint and dismiss all the inferior agents. Every quarter, or at least, every half year, they examine the accounts of the treasurers, compare them with the company's books, strike the balance, and certify it. In the case of the supercession, the dismissal, or the decease of a treasurer, or of any other accountable officers, the persons superseded or dismissed, or the heirs of the deceased, must, within twenty four days after being cited, present to the committee the books, accounts, and papers of every kind, under pain of paying fifty pounds sterling as a penalty for each refusal.

The committee make purchases of land and of materials; they sanction the contracts for labour. The checks for payment which they deliver, the accounts of the expenses and the receipts, the plans and the contracts, are carefully transcribed into books kept in their office. Any shareholder may inspect these books whenever he pleases.

In order that the funds of the subscribers may not remain unproductive, the committee fix the payment by small instalments; for instance, they require in the first place only the tenth of a share; they wait until this sum be exhausted before they demand a second tenth, and so on with the rest. The law fixes the *minimum* of the time which must elapse, 1st, between the different call for funds; 2d, between the advertisement of each call inserted in the public papers of the district, and the payment of the sums demanded. Thus the shareholders have only very inconsiderable sums to pay on each instalment; they are besides allowed all the necessary time for paying them.

If any subscriber neglect or refuse to pay at the period legally fixed, the committee may institute an action against him. If within three months after the order to pay, a subscriber has not complied therewith, the whole of his shares and the benefits arising therefrom are forfeited and divided among the rest of the shareholders. But it is necessary that notice should be served on the subscriber so refusing or neglecting, and published in the newspapers.—Finally the forfeiture must be in consequence of the order of a general meeting.

Sub-Committees.

If the business is more extensive and various than the managing committee is able to transact, sub-committees are instituted, to which certain departments are delegated; but the managing committee can alone give orders to the general agents, the treasurers, the secretaries, the engineers, *&c.* This committee also retains the right of suppressing the sub-committees and removing the members thereof, who have forfeited their confidence. The sub-committees are governed by the same rules as the managing committee. They decide by a majority, and they leave the chairman a casting vote.

Arbitrating Commissioners.

These are appointed by name in the act of parliament, as a grand jury, and frequently consist of more than sixty members. They are selected from amongst the most respectable inhabitants, to decide between the company and the proprietors on the banks of the canal. They must, 1st, reside in one of the counties interested in the canal; 2d, be holders of real property, producing a certain revenue, or proprietors of a proportionate capital; 3d, fill none of the lucrative employments under the company; 4th, have no interest in the canal, nor in the affairs submitted to their arbitration, They are required to make oath that they fulfil these conditions under a heavy penalty paid to the company, and the expense of the process. If a commissioner die, or resign, or cease to inhabit one of the counties through which the canal passes, his colleagues must meet and elect a successor by a majority of votes.

If the commissioners neglect to complete their number and remain under the *minimum* fixed by law for arbitrating, the company apply to the justices of the peace, who are in such cases authorized to fill up the vacant places. Every justice of the peace may himself be a commissioner. If a moiety of the shareholders, or merely one owner, or one occupier of the land appropriated to the canal, address a written requisition to three arbitrating commissioners to call a general meeting, they are bound to comply therewith, within the next seven days. This meeting must take place within twenty-one days at the latest from the date of the order for calling it, which must be advertised in the newspapers of the district fourteen days previous to the time fixed by the commissioners.

The place of the meeting at which any question respecting landed property is to be agitated, must not be more than two miles from the spot of ground in litigation. The arbitrators on assembling, choose their secretary from among three candidates presented by the company, by whom the salary of the secretary is paid, and they cause him to enter in a particular book the minutes of their deliberations, which all the commissioners are bound to sign.

In this manner the commissioners value the property acquired by the company, and the indemnities to be paid to the owners and occupiers of lands which may have been damaged by the company's works, or by the overflowing of the canal. They are bound to decide according to the evidence of respectable witnesses, who make their deposisitions on oath. If one of the parties object to the arbitration, the sheriff summonses a jury of twelve*. The commissioners may require this jury to hear the witnesses they summon, and to visit the spots in litigation before they fix the sum to be paid by the company. The commissioners afterwards exercise the office of judges, and order the verdict of the jury to be executed.

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* The sheriff who should refuse or neglect to summon the jury when required, is liable to a penalty not less than 20*l.*, nor more than 50*l.* A juryman who should refuse to discharge his functions, becomes liable to a penalty of 5*l.* Every witness summoned to give his testimony on the questions in litigation pays 5*l.* if he neglect to appear. These penalties, which are fixed by the commissioners, are applied to indemnify the persons who, in consequence of the absence of the offender, may sustain loss or damage.

False testimony, given intentionally, before the commissioners, the jurors, or the judges, on interests relative to the canal, is punished as wilful perjury.

The commissioners are empowered to allow to the jurors and the witnesses, a compensation for their loss of time, and for their expenses. This allowance is paid by the company, if the offer which they made to the other party be inferior to the value fixed by the jury; it is payable by the proprietors, if the offer which they refused to accept be greater than the sum granted, in consequence of the trial. The same regulation holds with respect to roads.

To prevent this regulation from being defeated, every proprietor, who in order to obtain a higher valuation for his land, wishes to bring the company before a jury, must, in the first place, produce to the treasurer of the company two sureties, who shall bind themselves to pay a certain penalty, and the expenses of the process, if the verdict of the jury be not for a larger sum than the company's offer. This is an excellent regulation and ought to be adopted by us.

The valuations of the commissioners and the jurors are entered in a book kept in the office of the clerk to the magistrates of the district wherein the dispute arose. This record may be inspected upon paying one shilling.

It belongs to the commissioners to decide on the towing paths, on the quays, and the warehouses, which are required by the company as necessary for the canal, and which must be constructed on grounds, the property of individuals. If within six months after notice given, these individuals do not execute the required works, the company is entitled, in spite of all opposition, to take possession of the ground, indispensable for such constructions. However, buildings, courts of houses, and avenues leading to them, parks, gardens, and enclosures, cannot be taken without the consent of the owners.

The Company's Purchases.

The principles adopted on this subject in England may furnish useful hints for our legislation on public works. They are in substance as follows:—

The company must continue to pay the same taxes* as the former possessors on all the lands which they acquire.

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* If the canal pass through infeoffed land, that part of the canal remains subject to the charges on the land; unless the lord of the manor agree to the redemption of such charges. The company must indemnify the proprietors of tithes on the ground which they acquire. The ecclesiastical revenues are converted into perpetual rents. Fortunately for us these two points have nothing in common with our laws.

When they purchase only a part of a piece of land, if the owner of the remainder agrees to take upon himself the payment of all the taxes, present and future, the company are legally relieved from that charge. Besides, the canal with all its accessories, considered as the acquisition of the company, is independent of any public or private jurisdiction and of the laws relative to water-courses, which come under the jurisdiction of the public.

The company acquire the right of property over all the grounds which fall within the breadth of the navigable line*, fixed by the act of parliament, and the detailed plan accompanying it, and which are specified in the lists of *assent*, *dissent*, or *neutrality*, prepared from the beginning. But the company cannot deviate from the line marked out in the plan, and the descriptions submitted to parliament, unless they obtain the written or formal consent of each proprietor of the grounds, comprehended in the new line.

The act of parliament authorizes the king, corporations, guardians, husbands, testamentary executors, trustees, *&c.*, to deliver up without delay the public or private property intrusted to them, and which may be necessary for the formation of the canal, or the works depending thereon. The law permits them to alienate all such parcels of land as may be detached or divided by the canal in such manner as to render the working thereof difficult and expensive. Moreover, if lands be separated by the canal into such small portions, as to have on each side not more in superficies than two acres, or sixty feet in breadth, whatever may be their length, and if the owner have no contiguous property, he can oblige the company to purchase those parcels of land at the same rate as the part occupied by the canal. To prevent disputes and actions at law, the company may purchase any piece of ground liable to be damaged by the works, and may sell it again, giving the preference to the former possessor. The owners of land and their representatives are authorized to claim indemnity for all damage and loss occasioned by the construction of the canal. They are entitled to levy such indemnity from the tolls, and even to seize the boats and merchandise of the company, if the liquidation of the debt be delayed.

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* If on this line there be grounds, the names of the proprietors of which have been omitted, or improperly engrossed in the act of parliament, on proof of such errors, by the commissioners, they are without difficulty rectified.

The company cannot take possession of land, until after payment of the price stipulated, either by an amicable agreement, or judicial decision. If the owner refuse to receive this value, or if he cannot be found, or is unknown, the company pay the sum into the Bank of England, or keep it in their own hands, on giving proper security.

The company must pay into the bank of England all sums exceeding 20*l.* due to corporations, or to persons who do not exercise their right of property, such as minors, *&c.* If the sum be below 20*l.* it is placed at the disposal of the administrators of the property, to be by them employed in the most useful manner.

If the lands are mortgaged, the company is authorized to pay the capital and interest thereon to the holders of the mortgage; but six months previous notice must be given of the intention so to do. On the refusal of a creditor to be paid off in this way, the interest on his mortgage is disallowed, and the company is relieved on paying the sum refused into the bank of England.

When more than ten years have elapsed after the purchase of the ground, without the canal being finished, or when more than five years have elapsed from the termination of the works, the proprietors may resume possession of their lands, on paying to the company a sum, estimated by arbitration, and which cannot exceed the price of the original sale. To give precise ideas on this subject, the numerical values mentioned in this chapter, have been copied from the act of parliament for instituting a particular company; that of the Croydon canal, which M. Cordier has translated and published.

BOOK III.

ESTABLISHMENTS OF ROADS, STREETS, &c.

CHAPTER I.

Establishments of Streets and Paved Roads.

ON visiting the squares and streets in the great towns of England, the traveller is struck with the cleanliness, propriety, and arrangement, which they exhibit. We have already explained the legislative measures to which the towns of Great Britain are indebted for these advantages. We may add, that the arrangements of the houses and their dependencies, are in the highest degree calculated to combine with the essential objects of a good system of street regulation.

In the best parts of the principal towns in England, the fronts of the houses are separated from the street by an area, surrounded by an iron railing; and this railing is separated from the horse-road by a broad foot-pavement. Thus the walls of the houses are not disfigured by dirt and splashes, as is the case in the towns of France.

It would be highly advantageous to adopt in our towns the plan of making foot-paths, not like those on our quays and bridges, but paved with beautiful flag stones, which are always clean and never fatiguing to the pedestrian. Care should be taken not to lay down these flags at the edge of the pavement, (as has been done in the Rue des Coquillis), because the carriages passing over them, force them in, and in wet weather, occasion puddles.

Projecting entrance gates, which obstruct the line of the foot-path in France are scarcely ever to be seen in the towns of England. A few narrow passages, at the back of the principal streets, lead to ranges of stables and coach-houses, which are on all sides surrounded by buildings, and are wholly detached from the thoroughfares for foot-passengers and carriages. By this excellent arrangement, the houses of gentlemen are entirely kept free of the noise and dirt, to which our mansions are exposed through their vicinity to coach-houses and stables. It were to be wished that this plan of separation were adopted in the elegant parts of the towns of France.

In the most modern parts of London, the extensive proportions of the streets, present the imposing appearance of a great capital. In Oxford-street, which is more than a mile in length, five carriages may drive abreast, between two broad foot pavements. These dimensions are indispensable in the most commercial city in the world.

A part of the Rues Saint-Honoré and Saint-

Antoine, the Rues de Rivoli, de Castiglione and de la Paix, are almost the only parts of Paris, whose dimensions suffice for the traffic of a great city in which trade and manufactures flourish.

A plan was in agitation for opening a wide street, which was to run in a right line from the centre of the front of the Louvre to the Place de la Bastile. The expense of purchasing the houses which must have been pulled down to make this improvement, would not have amounted to more than nine millions of francs; and this sum would soon have been repaid by the increased value of the ground on which the houses of the new street would have been built. Why was this admirable plan abandoned? Can it not be resumed? It certainly is a duty to execute this plan, when we consider the advantages which the new opening would afford to trade; for conveyances of every kind proceeding in directions parallel with the Seine, would pass along a level, straight, and convenient street, and avoid the winding course, and the abrupt and dangerous ascents and descents, occasioned by the approaches to the bridges along the quays.

Let us hope that the ministry and the chambers will unite their exertions, to raise the funds necessary for an enterprise, which would call forth sentiments of gratitude to the government; and which would be eminently popular, because it would be eminently useful.

It must be acknowledged, that in building the new streets of Paris, not the least knowledge of the proportions suitable to the public thoroughfares of a great capital, has been evinced. Every sensible person must be astonished at the short-sighted calculation of those speculators, who for the sake of giving a little additional size to the houses instead of raising the value of those houses, by building them in streets, whose dimensions would entitle them to rank as the first in the capital, have preferred building mere lanes, into which light and air can scarcely penetrate. It is for the local magistracy of Paris to lay down regulations against the building of these narrow streets, and to prevent speculators from disfiguring, by their present stupid and sordid system, a city whose monuments would entitle it to rank among the finest capitals of the civilized world, if its public thoroughfares were kept in better condition, and were better proportioned for the purposes of business and pleasure.

One thing which materially contributes to embellish the principal cities in England, is the custom of forming regular and spacious squares, in the centre of which, are gardens surrounded by elegant railings. In these gardens, the verdant grass plots are intercepted by long walks covered with yellow sand, shaded with trees and bordered with flower-beds. The sight of fresh verdure is an agreeable relief to the eye in the midst of a crowded city. This vegetation, moreover, contributes to purify the atmosphere; it absorbs a great portion of the rain, and diminishes the mass of water which it is necessary to carry off by drains. The gardens of the squares, are open only to the inhabitants of the surrounding houses, who defray the expense of keping them in order. Thus the public at large are not called upon to maintain an expense which contributes to render the town at once pleasant and healthful. In building new streets, care is taken to make them open into these squares which are adorned equally by art and by nature. When improvements and enlargements take place, plans are drawn out before hand, and private individuals are obliged to conform to them. In describing the works of the New Town of Edinburgh, we shall notice a remarkable example of this wise regulation*.

We will now speak of the superficies of the streets and roads in England. At first, carriage-roads were formed merely by enlarging the paths made for horses; then by laying down gravel extracted from the neighbouring ground. Down to the year 1542, even the streets of London were made in this way. According to the records of parliament, it appears, that at the period when the new method of making roads was proposed to be extended to the distance of a few miles beyond the capital, great opposition was raised by the neighbouring landowners. They wished to retain their monopoly of supplying the capital with provisions.

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* How happens it that in the Chausèe-d'Antin, which has almost all been built since the middle of the last century, the public authorities, who so ably carry many designs into effect, did not trace out a single square worthy to adorn that beautiful district of the French capital? For example, what a magnificent effect might have been produced by a regular and spacious square adorned with verdure and flowers, situated at the point at which the Rues du Mont-Blanc and de Saint-Lazare cross each other? Might not a square be equally well situated in the middle of the Rue de Richelieu? The most suitable points for new squares, would be at the ends of the principal bridges, and at the points

There are still some gravel roads in the best parts of London. In the country, paved roads are almost an exception. Lancashire is the only county in which they are to be met with beyond the boundaries of the towns.

The gravel roads in London present the finest possible appearance. Even in winter, scarcely a rut is to be seen upon them. However, they are found to be more fatiguing to horses than paved roads. The road surveyors who were examined before the special committee of 1819, affirmed, that

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at which the principal streets meet. It is but just to confess, however, that in this respect, Paris has materially gained since the revolution. The Places du Châtelet; de Saint-Sulpice, de la Bastile, du Carrousel, are ornaments which may be cited as models. But none of these places are yet entirely cleared, any more than the enclosure formed by the Tuileries, the Louvre, and the lateral galleries, which from its extent, is worthy of the monuments of Sesostris and the glory of Thebes. In short in all the cities of France, improvements for securing health and safety and facility of communication, have yet to be effected. They ought to be objects of emulation to our magistracy.

taking the average of every day in the year, horses will go through more work with the same degree of fatigue on a paved road than on a gravel road, if the draught be considerable. This assertion is confirmed by the experiments made by Mr. Edgeworth, who, in his work on roads and carriages, declares himself decidedly in favour of paved roads for all places where there is active traffic.

In the Commercial road, which leads from the docks to the city of London, the centre is paved and the sides are covered with gravel. Mr. Walker, the engineer of this road, proposed that an additional space of from ten to twelve feet, on either side, should be paved for heavy carriages, and that the middle should be reserved for light and rapid transport. Thus the parts covered with gravel would have been devoted entirely to foot passengers. On the subject of paving, Mr. Walker gives some hints which seem to be well worthy of adoption.

The stones should be cut, not in the form of a cone, but in the form of a cube, and made so as to join as exactly as possible. Care should be taken to pick all the stones which are of the same width and height, so that they may be laid down in uniform rows, which, besides the regularity of their appearance, possess the advantage of resisting pressure equally along their whole length. The stones, after being laid down, are beaten in, and those which sink below the common level are immediately removed. The interstices between the stones, are filled up with fine sand. All the pavement that has been laid down in the morning, should, if possible, be watered in the evening. Next day it should be again beaten in, and covered with a layer of fine sand, from two to three inches in thickness, which gives the road time to consolidate without the violent concussions occasioned by the passage of wheeled vehicles.

Mr. Walker has found it to be a very advantageous plan to fill up the crevices between the stones with lime-water, or to mix for the same purpose, some scales or filings of iron with gravel. The water which runs along the pavement, filters through the crevices, and oxydes the iron, which, together with the gravel, forms a solid body which adheres to the stones. Mr. Walker estimates the amount of the burdens annually conveyed along the Commercial Road, at 250,000 tons. Calculating at three shillings the price of conveying each ton on the paved road, the transport of each ton would cost at least four shillings on the gravel road. By this means, there would be in one year a saving of 12,500*l.*, a sum almost equal to the original expense of the paving.

Sometimes those parts of the carriage road over which the wheels roll, are covered with free-stone. This method is adopted on the quays of the London Docks, as in the streets of Florence. It has the advantage of suppressing the resistance occasioned by the jirking of the wheels on the pavement. We may observe, that roads made in this manner, may be crossed with ease in any direction.

We will describe, in chap. 6, the iron rail-ways which are sometimes made in the interior of towns. It was even attempted to cover the streets entirely with iron pavement. The plates representing this kind of pavement, afford a more accurate idea of it than could be conveyed by a long description. I have seen specimens of this pavement in London, near Blackfriars bridge and Leicester-square.

The enormous expense of this iron pavement, has hitherto prevented it from being extensively adopted. Yet this expense must appear less excessive in London than elsewhere, owing to the dearness of the ordinary pavement, for the horse-roads are made of granite brought from Scotland and Cornwall, and the flag stones are brought from the peninsula of Portland, on the coast of Dorsetshire. The conveyance of these materials is a considerable branch of mercantile navigation.

CHAPTER II.

System of laying out Roads.

The old roads of England were at first merely paths for foot travellers, and were traced out without any kind of method. These paths which were enlarged in course of time, have served successively for the passage of horses and carriages. To this origin may be attributed the windings, and particularly the rapid slopes which the roads in many places present. We know, indeed, that the directions which are preferable for foot travellers, are in many cases very different from those which are suitable for horses and carriages. The limit of the slopes beyond which it would not be advantageous to follow the direct road, is much less restricted for foot travellers than for horses, and for saddle horses and beasts of burden, than for the teams attached to wheeled vehicles.

The roads destined for foot passengers, having been originally mere paths traced by the footsteps of the huntsman and the peasant, were turned aside from their natural direction by every obstacle which the nature of the ground presented, which obstacles are however now considerably diminished. Thus many roads were carried over heights to avoid marshes which are now dried up and rendered passable; others deviated from their natural course, that they might be made to communicate with the fords of torrents and rivers, whilst these water-courses can now be crossed by the bridges, which have been subsequently built in favourable situations.

When the necessity for more extended and easy communications increased with the progress of manufactures and trade, the roads were gradually enlarged and improved, and pains were taken to render them more straight and to lessen the abruptness of their turns and slopes. But these works have been very slow in their progress; they are yet far from being completed; and the state of the roads in England still affords scope for the exercise of that spirit of improvement by which the English people are animated.

In order to examine regularly the configuration of the roads, we will consider, following the direction of their length, first, the appearance they present when viewed vertically and horizontally, and next their transversal form, that is to say their profile.

The three kingdoms of Great Britain no where present those immense plains, whose perfect level admits of roads being made horizontal along their whole extent. The English would not even prefer level roads, to those which are varied by gentle slopes and by continual undulations. In Great Britain, it is almost a generally received opinion, that a perfectly horizontal road is more fatiguing both to horses and foot travellers, than a road interspersed with gentle rises and falls; because it is said, the alternations of ascent, descent and level ground, requiring by turns the exercise of different muscles, afford rest to those which are for the moment least exerted, and successively bring them all into action.

Great Britain is divided throughout its whole length by a chain of mountains, crossed by numerous roads. In carrying the roads over this chain of mountains, and the hills attached to them, care has not always been taken to select the least elevated defiles, so that the highest point of ascent might be rendered as low as possible. We frequently meet with ascents and descents which might have been easily avoided, either by keeping along the brows of the hills, or by carrying the line of road through valleys, whose course does not form a considerable angle with the shortest course that might be mathematically traced out*. For some time past great pains have been taken to avoid these useless ascents and descents†, in Wales and in the north of Great Britain; but much still remains to be done in the southern parts.

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* It will of course be understood, that to the geometrical consideration of the length of the roads, must be added other considerations relative to the nature of the ground, the expense, *&c.*

† In the mountainous parts of England, the slopes of the hills are from $\frac{2}{100}$ to $\frac{5}{100}$. However, there are roads in Devonshire and other parts of England, where the slopes are between $\frac{15}{100}$ to $\frac{20}{100}$.

In England, stage coaches, private carriages and carts of light burden, proceed at a trotting pace both in the ascents and descents of the road. Even the greatest slopes cannot therefore be very considerable. Edgeworth calculates that two degrees of inclination are the maximum of these slopes; and Mr. Telford has adopted this proportion as the basis of his improvements on the road leading to Ireland, which passes through Wales and the island of Anglesea. This road presented in many parts, ascents of $\frac{1}{12}$ or $\frac{1}{10}$, and in some places of $\frac{1}{9}$ or even $\frac{1}{7}$ per unit of horizontal length. In proportion as these ascents were fatiguing, the descents were dangerous, particularly for vehicles proceeding at a rapid rate.

In France, notwithstanding all the improvements we have made in our roads, we are yet far from having reduced the slopes to the limits now presented to the slopes in Wales. In proportion as the progress of our trade and manufactures, demands a more speedy, and secure course of communication, the rapid slopes which are the evil of many of our public roads, will doubtless be diminished. We should henceforward lay down the regulation of not giving more than $\frac{1}{30}$ to the most extended ascents, or more than $\frac{1}{25}$ to short ascents.

For some time past the English engineers who are engaged in diminishing the too rapid slopes of the old roads, have endeavoured to preserve the same degree of slope without interruption along the whole length of an ascent. However, when the ascent is long, it would be advisable to make [levels at certain intervals, which would afford resting places for horses and beasts of burden.

When it is not possible to avoid the ascent and descent of a rapidly-sloping hill, without considerably increasing the length of the road, the summit of the elevation is lowered by means of cutting, and the materials thus removed are usually employed in raising the lower part of the road. In districts where there are calcareous hills, the ascents and descents may be considerably diminished by cutting; for the material removed will supply lime to the whole neighbourhood, by which means the expense of the operation will be in part, and often entirely covered.

In the winter of 1817, when the dearness of provisions reduced numbers of unemployed labourers to the lowest degree of misery, many great works of the above kind were undertaken: they had the twofold advantage of improving the condition of the public roads, and rescuing the poor from the horrors of famine. This was turning even adversity to good account, in order to secure new and lasting sources of comfort and prosperity.

We will now consider the direction of the roads in their horizontal point of view, that is to say without regard to their ascents and descents. Even con-

considered in this way, it will be found that English roads present numerous sinuosities, some very decided, and others gently undulated. Abrupt and dangerous turnings disfigure them in many parts. Some of these inconveniences may even be attributed to the social organization of the British people.

It is well known that England is divided into numerous and extensive landed estates, the owners of which reside upon them during a considerable portion of the year. In these country residences they exercise almost all judicial and municipal functions. They thus possess the two-fold influence of wealth and magistracy; and this influence they employ to promote their own personal interests, which are sometimes allowed to interfere with the public good. They are doubtless solicitous to keep their roads in a state of perfect repair, because their own vehicles and those of their tenants must very frequently pass along them. But the patriotism of these individuals rarely induces them to allow the roads to be carried through their vast enclosures, and the public road frequently takes a considerable turn to suit the convenience of some great landed proprietor whose fields happen to be situated in the direct line along which it would be most advantageous to carry the road. For some years past the attention of parliament has been turned to the amendment of the inconvenience above alluded to.

In order to accelerate and secure the improvements which may be effected in the laying out and the structure of roads, the best informed men who have written on the subject propose that from time to time surveyors should be appointed to visit the principal roads, and to determine the improvements that may be deemed advantageous to the public. These regulations might be sanctioned by act of parliament, and the magistrates might cause them to be executed by parochial surveyors.

In France we possess a body of general inspectors, who combining knowledge with independence may enable us to reach, by the opposite extremity, that middle course to which the English look forward as to the point of perfection. For this purpose it would be sufficient to attach to the different territorial divisions of France, engineers who would identify themselves with the interests of the districts whose works might be intrusted to them. In Book I. we have suggested the means by which these objects might be fulfilled.

We have already observed that the English would dislike to have their roads in all parts perfectly horizontal. Roads exactly straight, whatever might be their ascent and descent, would be still more repugnant to their taste. It is easy to account for this aversion, which has not hitherto been shared by the French. So long as the windings of a road do not form any very considerable angles with its direct course the straight road is very little shorter than the winding road. Consequently the latter occasions only a little extra expense for its construction and support; and the transports which are made upon it require only a trifling addition of time and strength. These little turnings produce an agreeable effect for the surrounding scenery; so that the road becomes an ornament to the country, and the country itself is exhibited to the best advantage to the eye of the traveller, who by the course of the road is led to those points which command the most pleasing prospects. Why should we neglect this mode of enhancing the enjoyment of the beauties of nature, when in our cities we expend such considerable sums in futile amusements, and in pleasures less pure and positive?

We may add, that by giving a gently winding direction to the roads, foot passengers, horsemen, and travellers in open carriages are relieved from the fatiguing and tiresome prospect of a course which seems interminable.

Roads and Walks in Pleasure Grounds.

In the art of laying out English pleasure-grounds, that is to say, the art of augmenting the beauties of nature by varied plantations, in order to impart to the face of the country an air of luxuriance, simplicity, grace, or grandeur, great importance is attached to the directions given to the paths and roads. These, by taking easy turns and apparently natural courses, alternately conceal and unfold the contrast and harmony of all the beauties presented by a rich and grand landscape. In those delightful situations where gardens, parks, and woods, neighbouring and remote estates, present such a harmony of effect that they seem to form but one vast domain, without barriers and without incongruities, care should be taken to banish all appearance of forms fixed by the cold calculation of the geometrical compass, or of constraints imposed by a hand capricious even in its regularity.

In the laying out of pleasure-grounds the object is to bring the traveller to his destination, not by the most rapid but by the most pleasing course. There should be no appearance of unnatural and forced turnings in the road, along which the idle spectator strolls for the sake of gentle exercise and agreeable recreation, and not for continued fatigue. When we are surrounded by the beautiful scenery of nature, without even taking heed of the vague desire we feel to visit the most attractive spots, our course is not, as it might be supposed, arbitrary and entirely capricious. At each new point of view some other point generally opens upon us, and seems to promise new sensations of a more forcible or a more pleasing kind. To this spot our imagination prompts us to repair, and thither the road or path, skilfully traced out, should conduct us. To combine the prospects of an extensive tract of country—to contrive that they shall by turns excite curiosity, and produce on the mind lively or melancholy, imposing or pleasing impressions—to exercise ingenuity in thus creating happy contrasts,—this is the talent of adorning and displaying nature; and this talent may, without hesitation, be ranked among the fine arts, since it has imagination for its means, and ideal beauty for its object.

The English have not only paths and narrow alleys for visiting their parks and gardens on foot;—the principal parts of their vast possessions are intersected by roads called walks *, which are sufficiently wide to admit of the passage of horses and carriages. These walks are carefully covered with sand, or with a mixture of sand, and gravel. Enormous iron cylinders are frequently rolled over them to render them firm and smooth.

To enjoy these walks and rides in perfection, one should visit the country in fine autumn or summer weather; for in England, even in the fruit season, the verdure and flowers retain the freshness of spring and the sweetness of their early perfume. When, seated in a light elastic open carriage, drawn by horses whose swiftness might have been envied at the games of Olympus, we drive along, sometimes beneath the shade of thickly-planted trees, and sometimes on the brow of a hill, whose declivity, gently uniting with the plain, unfolds a magnificent

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* They are also called ride-roads. The English, who go much on horseback and in carriages, have a particular verb to express this action, namely, *to ride.* We have no analogous verb in French.

amphitheatre of fields, gardens, meadows, and forests,—and when without feeling our motion, we are transported to an open space smoothed with more art than the Hippodromus;—a thousand varied and yet harmonious sensations take possession of the mind; a feeling of repose in motion, and of security in a course in which we seem to be removed from the earth, produces a thrilling of pure delight throughout the whole frame; and at the moment when nature smiles with her utmost grace, to rouse the soul to enthusiasm! Well do I conceive why the wealthy inhabitants of Great Britain should hastily desert the gayest and most brilliant capitals of Europe, for the sake of enjoying in silence and tranquillity the innocent and delightful pleasures which await them at home.

In recalling these scenes to my mind, I feel the full force of their enchantment; and yet, when they were present to me, they wanted, in my eyes, the charm which the enamoured Rinaldo felt to be absent even in the gardens of Armida. This charm is the happiness we experience at sight of the beauties of our native land, which immediately arouse feelings of noble patriotism, and revive the sweet recollections of our youthful years. In contemplating the sublime landscapes of England and Scotland, I could not, therefore, feel that which to the patriotic inhabitants of those countries must constitute their highest attraction.

The "Jardins" of Delille, in offering to our view an idea of the embellishments of the country in England, has produced amongst us nothing but awkward and poor imitations. Our decorators thought that the character of an English garden consisted in presenting the most tortuous roads, and the most painfully worked-up grounds. In attempting to produce great effects upon confined stages, they have produced nothing but ridiculous caricatures.

In Great Britain we never see a straight avenue leading from the public road to those pretty modest residences called *cottages*, which hold a middle rank between our *chaumiéres* and *châteaux*. There are no avenues of trees ranged in right lines as it were for the purpose of announcing these pleasure-houses, or rather palaces, in which all the luxuriance of architecture and sculpture seems to vie with the richness of nature herself. Instead of endeavouring to display the beauties of art from the most distant point possible, the English endeavour to conceal them. Nothing is more repugnant to English taste than those long and gloomy avenues which exhibit, from the distance of a quarter of a league, the front of the building, and the formal plantations before it; whilst, on either side of these regular rows of trees, the eye perceives nothing but fields devoid of taste, and exhibiting a spectacle of desolation and barrenness. The English country-residence is, on the contrary, approached by a walk running between groves and carpets of verdure; the different parts of the structure are discovered at intervals; but you do not perceive the whole edifice until you arrive at the point whence the whole can be comprised in a single glance, and which developes just so much of detail as to allow no beauty to be diminished or lost by the effect of distance.

This digression on gardens and pleasure-grounds will doubtless be pardoned. It is proper to communicate to our countrymen, not only that which is useful, but also that which may contribute to adorn the French territory. The land of the fine arts should exhibit beauty in the cultivation of its fields and plantations, as well as in the laying out of the public and private roads which intersect, in every direction, a country eminently favoured by nature. It is not enough that our towns should be the centre of talent and taste. Our country, adorned with luxuriant plantations and elegant structures, should present, sometimes, boldness and grandeur; sometimes, simplicity and grace; thus reflecting the varied and true character of a people, who are capable of reaching to the highest conceptions of science and the arts, without being the less sensible to the sweet enjoyments of nature.

CHAPTER III.

On the form of Roads.

Roads devoted to the public utility, whatever may be their degrees of importance, should all be laid out on the same principles; but when considered with respect to their width, they present great degrees of difference, to which it is proper to devote attention.

The narrowest limits which the law permits to be given to bye-roads are as follows:—foot-paths six feet and a half; horse-roads, eight feet; carriage-roads, twenty feet. We have mentioned (Book I. Chap. 2,) the regulations which prescribe the enlarging of these roads when necessary. Their width may extend to thirty feet. The highways may be sixteen feet six inches wide in the horse-road; the width of the foot-path and ditch together may vary from eight to ten feet.

It is determined, by Act of Parliament, that the width of the turnpike-roads shall be sixty feet, at the approach to populous towns. By some, this width has been disapproved of, as being a great waste of ground. It has been observed that the weeds which spring up along the sides of these wide roads, scatter their seeds over the adjoining fields; and it has been suggested, that in those parts of the road which present an excessive degree of width, slips of ground on either side might be sold. The expense of supporting the road would, by this means, be diminished, the extent of cultivated land would be increased, sites would be obtained for building houses for the labourers, and there might be reserved, beyond the limits of the road, sufficient space for depositing the materials necessary for the road work.

Roads should be widest and most solid in the most frequented places; for example, at the approaches to the capital and to manufacturing, trading, and sea-port towns. Finally, the road should in no part be so narrow as to render it difficult for two vehicles to pass each other, which is still the case in many parts of England.

The English roads present, indeed, the most striking inequalities in their width. In the neighbourhood of the capital, and in the approaches to the principal towns, the roads are (in conformity with the regulation above mentioned) sixty feet in width; but at a short distance from the principal towns, it frequently happens that their dimensions are reduced to eighteen feet. Before the great improvements which have recently been made on the road from London to Holyhead, it was in several parts not so much as thirteen feet wide*. It must, however, be observed, that the excellent police-regulations respecting driving, and the care that is taken to keep the public thoroughfare perfectly clear, enable the English, without inconvenience, to make their roads much narrower than ours, though they maintain a much more active traffic on them.

We may close our remarks relative to the width of roads, by stating that the widening of the narrow parts of the roads in England is a subject to which the attention of trustees, and also of parliament, has lately been earnestly directed. In a few years hence the public roads in all parts of the three kingdoms will be sufficiently spacious to afford facility to the conveyance pertaining to the most extensive trade.

The French seem to have fallen into a fault, the reverse of that which the English are now endeavouring to correct. Many of our roads are extremely extensive, and in many parts their width is out of all proportion to the traffic which is kept up on them. It is absurd to allow roads, in the least frequented districts, to preserve the same dimensions as those which lead to the capital and great towns.

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* When the principal roads do not exceed twenty feet in width, it is observed in England, that the meeting of vehicles driving at a rapid rate, and the passage of numerous flocks, occasion great trouble and delay, and frequently give rise to serious accidents.

Many persons, however, regard this excessive width of the public roads as a sign, and almost as an emblem, of moral and political greatness. They judge of empires according to the amplitude of these superb and expensive zones, as the vulgar judge of great noblemen, according to the breadth and glitter of the lace which adorns the liveries of their servants. Let us hope that in due time the progress of reason will banish these absurd opinions.

Profile of Roads.

On this subject we will begin by giving a few details respecting bye-ways, for which so much still remains to be done in France. The plan of giving to these roads the same degree of elevation, or rather the same degree of depression towards each of their sides, soon occasions two deep hollows to be formed, which get filled up with water; while a third hollow is traced in the middle by the horses' feet, by which means there is no dry path left for foot-passengers. The idea of making these roads incline only to one of their sides has, therefore, been adopted. By this means the highest side is at all times dry and passable to foot-travellers. This plan has also the advantage of rendering the ruts less inconvenient. Bye-ways from ten to twelve feet in width, which have been made to slope in this manner, have been found to be sensibly improved.

If, during the winter, water is likely to descend upon the road from its upper edge, to prevent inundation, it is necessary to dig a narrow ditch along this edge. In certain cases, when the road is made, a lateral slope may be given to it, which throws off the water on the side whence the springs issue. The same ditch then serves for carrying off the spring-water and the rain-water.

Profile of Highways.

In England, very few of the highways have only a single lateral slope. Some have two slopes, which descend from the sides to the middle, like the gutters of many of our streets. The greater number, however, rise in the middle and fall on each side.

The latter form is particularly remarkable in the old roads, whose great convexity renders carriages very liable to overturn. The inconvenience of this form was not so sensibly felt in those times when wheeled vehicles proceeded at a very slow rate; but it has become more and more serious in proportion as the rapidity of conveyance has been increased. The natural progress of trade, and of social communication, has, therefore, proved the necessity of diminishing the convexity of roads.

Advantage is now taken of the lessons of experience; but still much remains to be done, even in those parts, where, for a length of time, the interests of trade have most loudly called for this important improvement. In the neighbourhood of London, that is to say, in the centre of the most active traffic, the roads are so convex, that carriages are obliged to drive along a dangerous slope, unless they are able to keep quite in the middle of the road. This is greatly owing to the bad plan on which the roads are repaired. Enormous quantities of gravel or stones are laid down in the middle. As it is known that these materials, owing to their spherical form, can never completely agglomerate and form a solid body, it is supposed that enough will always fall towards the sides, by yielding to the pressure of the wheels. We shall presently see that this inconvenience is remedied by the new modes of constructing and repairing roads.

It is observed in England, in favour of those roads which are perfectly level and slightly convex, that they retain much less water than that which lodges in the least ruts of the convex roads. It is, indeed, easy to conceive, that no lateral slope can be so great as to dislodge the water from these ruts, and carry it completely to the lower sides of the road.

According to Edgeworth, who has devoted considerable attention to the works of the public roads, a new road should never have a greater curve than that which is necessary to prevent it becoming concave before it has been used so long as to require a supply of fresh material. Mr. Telford, in the works which he has executed, and which render the road from London to Dublin a model in its kind, has given for the transversal inclination, no more than that which is produced by a rise of eight inches in a width of thirty-three feet. According to Mr. M'Adam, the engineer, who has introduced the new mode for repairing roads in England, it is sufficient to make a fall of three inches, on each side of a road of thirty-three feet in width.—Experience, he says, proves that this slope, slight as it is, is sufficient for carrying off the water, and keeping the road constantly dry.

From these details, it will be seen that the English engineers have given to the roads considerably less curve than is made by the French engineers. This plan is attended with great advantage to carriages; for when they proceed along a road that is not very convex, their wheels on both sides are almost always equally raised. Roads of a slight degree of convexity are also most agreeable to the traveller, as is evident from the fatigue that is experienced in driving for any length of time in a carriage along the side of a very convex road; particularly if one happens not to be seated in one of the lower corners of the carriage.

As we have above observed, roads of a concave form are also made in England; that is to say, roads which are less elevated in the middle than at the sides. Two roads of this kind, one of which passes through Mersham, and the other situated at a short distance from that place, are said to keep better in repair than any other roads in the neighbourhood. Mr. Wilkes has made a concave road at Bredon, which, it is affirmed, keeps in perfectly good condition. (See Mr. Beatson's work on *Landed Property.*)

There are roads made with longitudinal slopes, in such a manner that their profile mass may be perfectly horizontal. The advantages of this plan are:—1st, the inclination of the plane along which carriages pass is a minimum, as well as the fatigue of horses ascending, and the danger of horses descending; 2d, when the road is horizontal in the direction of its breadth, the wheels on both sides equally support the weight of the carriage, and the axle-trees, naves, and spokes, sustain less wear and tear.

The only difficulty that can arise from this plan, if the road be rectilinear, consists in making at intervals, transversal conduits*, which may not occasion too great a degree of jolting to wheeled vehicles. If the road be made to turn, the waters, in their natural course, will descend from the middle to the sides.

There are cases in which the plan of single transversal slopes, which have already been described in the article on by-roads, may be adopted on highways. Mr. Edgeworth, who recommends this plan, suggests, that a road traced along the side of a hill should receive a lateral slope, in a direction contrary to the slope of the hill. This plan would, particularly in turnings, greatly tend to obviate the risk of carriages in descending, being dragged by their weight, by their tangential force, or by the impetus of the horses, down the precipice on that side of the road which looks towards the lower part of the hill along which the road is traced. This side of the road, more elevated than the other, without any transversal slope, and firmly covered with stones, should be chosen by carriages ascending; while the inner side, presenting a counter slope, and not covered with stones, would acquire a degree of looseness very favourable to the draught of vehicles descending loaded. Finally, a foot-path, raised against the upper edge of the road, would serve as a barrier, and ensure the safety of travellers.

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* To avoid the jolting occasioned by these conduits, it has been proposed to make, at certain intervals, transversal drains under those parts of the road, where the longitudinal slope is considerable. See the Report laid before the House of Commons, by the Road Committee, in 1808.

The counter slopes, which have just been described, are included in the regulations which were adopted respecting the road works in the county of Selkirk, in Scotland*. In these roads, the counter slope is equal to a twenty-fourth part of the width of the road.

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* These regulations were drawn up by Mr. Alexander Melville, formerly superintendent of the roads in Selkirkshire.

"This plan," says a Parliamentary Report in which an account is given of the good effects it has produced, "precludes the formation of ice on the public way; by assisting the current of air, it also prevents these roads from being obstructed by the accumulation of snow. Besides these advantages, the system affords a greater security in passing by the sides of precipices."

This plan might be advantageously adopted in our departments of the Alps, the Pyrenees, Jura, *&c.*

The same regulations direct that a ridge of earth, nearly three feet in height, shall invariably be raised along the edge of the road. This is the most sure and economical means of preventing carriages, travellers, and horses, from falling down dangerous declivities.

Foot Paths of Roads.

England is now of all countries that in which people travel least on foot; and yet, of all modern nations, it is that in which most has been done to secure the comfort and convenience of foot-travellers. The smooth and well-beaten surface of the public roads in England, renders them in general not less pleasant than easy for walking in all their parts. However, to spare foot-travellers the trouble and fatigue of constantly standing aside to avoid coming in contact with wheeled vehicles, care has been taken to raise foot-paths * along the sides of most high roads, and particularly those in the neighbourhood of cities and towns. Strong posts, painted for the sake of preservation, are fixed up by the side of these foot-paths to prevent coaches and horses from encroaching on them. Drivers detected in the commission of this offence on turnpike-roads, would be subject to a very heavy penalty. It is curious that the same penalty is not extended to the commission of the same offence on open roads.

It would be easy to make foot-paths on many of our roads in France, which are much larger than is necessary for the passage of wheeled vehicles. Such an improvement would be eminently useful to the peasant, the mechanic, the soldier, and the poor traveller; and would call for sentiments of gratitude towards the legislature and the government †. May the prospect of augmenting the comforts of the

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* These foot-paths are from three to ten feet in width. They rise to the height of one foot above the horse-road, and in some few instances, even more.

† The Romans carried still farther their attention to the convenience and comfort of travellers. At certain distances along the Roman roads there were benches on which the foot-passenger might sit down and rest, stones to assist the horsemen to mount,

lower classes induce the ministry and the government to unite in voting and executing a measure which would be so highly useful and popular!

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and fountains for slaking the thirst of men, horses, &c. At present, even in our public promenades and royal gardens, the benches are being removed, and inferior officers blush not to deprive the public of these resting-places, in order that the chairs which they permit to be brought to these stations may be let at higher prices.

CHAPTER IV.

Construction of Roads.

During my travels in England, I everywhere admired the superior excellence of the roads, as compared with the generality of our own. Is this superiority to be attributed to Nature or to Art? Undoubtedly Nature has, in this respect, done much in favour of Great Britain. The soil of most of the counties produces materials well adapted to the construction of roads. The ground over which the roads are traced is, in many parts, naturally very firm, from being composed of a mixture of sand, gravel, and flint, which, at the same time, enables the water to filter easily through it, and thus leaves the road dry, almost immediately after rain. The climate of England too, though habitually damp, is not subject to those heavy torrents of rain which occasion such a rapid destruction of the roads in more southern countries.

These causes, however, are not sufficient to account for the excellence of the roads in Great Britain; for, in many parts of the North of England, and in Wales, where heavy rains are frequent, and where the waters run in rapid torrents, public roads have been constructed of a perfectly good quality. Indeed, even on marshy and clayey soils, roads have been formed remarkable for their solidity, durability, and dryness.

One circumstance which clearly proves, in opposition to the generally-received opinion, that the superiority of the English roads is not to be attributed to the excellence of the materials used in making them, is, that they are to be found in equal perfection, even when materials of the most different nature are employed. In some counties, as for instance, in Essex, Sussex, Shropshire, and Staffordshire, they make use of flints mixed with sand. In Somersetshire, Gloucestershire, and Wiltshire, limestone is chiefly used. This substance certainly offers but little resistance; yet when properly prepared and well laid down, it produces a compact and solid road, and binds more readily than any other material. Its only defect, therefore, is its want of durability.

It is very remarkable that the great high roads which run into London, and which from their beauty are the admiration of foreigners, are formed of the most defective materials, and on this account are, perhaps, the worst roads in all England. This defect is rendered still more serious from the immense traffic carried on upon these roads.

They are formed of a kind of gravel, composed of argil (clay) and small round flints. The spherical form of these flints prevents them from uniting like broken stones, the flat surfaces of which come together and produce, by the very pressure of the wheels, a compact mass which becomes daily more and more solid.

The existence of some absurd laws and regulations renders it impossible to supply the roads in the neighbourhood of London with good materials, which might easily be forwarded by the Thames, or by the numerous canals which converge towards the capital*.

Experience has proved, that to form roads of gravel mixed with earth, operates greatly against their solidity †. Consequently, before the gravel is laid down, care is taken to wash it well, or to sift it. Even then, it is observed, that the small quantity of earth which adheres to the pebbles in the gravel, is very prejudicial. This circumstance is particularly remarkable when the gravel, after being taken from the pit, is not left for a sufficient time to dry in the open air. The clayey earth which it still contains, is converted, by the effect of the rain, into a mass of thick and heavy mud, which it is necessary to clear away; and this operation, which is very expensive, might be avoided, by bestowing due attention to the first construction of the road. This negligence, and that of not breaking the stones of too large a size, which are mingled with the gravel that is extracted from the bed of the Thames, have hitherto rendered the roads in the neighbourhood of London, as we have before observed, infinitely inferior to those in many other parts of England.

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* Mr. M'Adam recommended that some facility should be afforded to the importation of chippings of granite from the quarries of Cornwall, Guernsey, and Scotland. He also suggested that the shingles thrown by the sea on the coasts of Essex, Kent, and Sussex, should be brought to London by the Thames. These shingles, when broken, would form excellent roads.

† On this point (as it is remarked in a Report of the Commissioners appointed to direct and execute the works of the road from London to Dublin,) all persons acquainted with the construction of roads are unanimous. The Commissioners, however, observe, (Rep. p. 100) that many surveyors adhering to old opinions, suppose that the earth will cement the stones. They conceive that a compound of materials, partly hard and partly soft, is better calculated to resist the pressure and friction of heavy wheels, than a mass consisting entirely of hard materials. This is an absurd prejudice which prevents the traffic of the roads from becoming so active as it might be. Gravel mixed with earth is always damp and soft, except during a few days of the year; and, in this state of humidity, by the constant pressure of the wheels, it breaks as fast as stones break in a potter's mill.

Experience demonstrates, that by the judicious employment of even gravel of the worst kind, a good road may be made. The Reading road in Berkshire has been rendered perfectly smooth, firm, and level, by the use of still worse gravel than that which is found in the neighbourhood of the capital. The wheels never make ruts on this road at any time or in any season.

The roads in the neighbourhood of London being extremely smooth, the traveller, in driving along them, free of all inconvenience from jolting, concludes without further examination, that they are in the best possible condition; but, drivers and postmasters form a different opinion of them. These roads have the fault of being extremely soft, particularly first after their construction and repair. For this reason the stage coaches, *&c.*, must be drawn by horses of very superior strength, to enable them to proceed as rapidly as they do at a greater distance from the capital. Notwithstanding their superior strength, the fatigue endured by these poor animals is so excessive, that they are rendered useless in the short space of three years! The foreigner justly admires the beauty of the horses attached to the public vehicles in the neighbourhood of London; but he is far from suspecting that the choice of these animals is occasioned by the very defects of the road which is so magnificent in appearance, and so pleasant to the traveller.

In those parts of Great Britain where the materials employed in making and repairing the roads are of good quality, there are essential differences in the manner of uniting them. Thus in Scotland, where in all parts of the country the materials for road-making are abundant and cheap, many of the roads are rough, loose, and extremely expensive in their construction, because the materials are not used in a proper manner.

Mr. M'Adam, one of the engineers who has most materially contributed to the improvement of the roads in England, and who has furnished us with many of the facts contained in this chapter and the succeeding one, has proved, by the works executed under his direction, that all roads may be made to retain an equal degree of smoothness and solidity, during all seasons of the year*. The method introduced by Mr. M'Adam ensures the good condition of the roads as long as they exist. The only question that can possibly arise, will relate to the expense or durability of the materials employed, and not to the excellence of the road itself.

The plan adopted by Mr. M'Adam, first in the neighbourhood of Bristol, then in the adjoining counties, and by degrees in all parts of England, has been completely successful. Roads repaired on this plan have been found to be so superior to all others, that by way of distinction, they have received the name of the inventor. To *Macadamize* a road, is to repair and improve it according to Mr. M'Adam's method.

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* When Mr. M'Adam returned from America in 1783, the works on the high roads of Scotland were proceeding. (The turnpike-act relative to Scotland existed for nearly twenty years.). He then came to England and was appointed a commissioner of roads at Bristol. He became an engineer, and set about improving the public roads in the neighbourhood of that city. He commenced his labours in the year 1816, and they were crowned with the most complete success. During the space of three years he repaired 160 miles of roads near Bristol; yet the floating debt, contracted by the trustees of these roads, which exceeded 1,400*l.* was liquidated; a considerable portion of the principal debt was reimbursed; and 2,790*l.* were lodged in the hands of the treasurer. Such were the effects of three years' good management on a portion of road which, during the twenty years it had been under the control of trustees, had increased its debt to 43,000*l.* (See Report of the Committee of 1819, pp. 18 and 19.)

Why should not we adopt this plan on almost all the roads in France?

M'Adam's plan consists in breaking into small pieces the stones which are employed in constructing and repairing the roads. This operation is performed by women and children, who sit down and break the stones with small hammers. No fragment of stone measuring more than an inch longitudinally, or weighing more than six ounces, is laid down on the road*. For ensuring the observance of this rule, the people who break the stones are furnished with sieves made of iron with circular holes, similar to those used by shot manufacturers for ascertaining the calibre of bullets. Every piece of stone that will not pass through this sieve is laid aside. Besides this instrument, Mr. M'Adam furnishes all the overseers of the work with a balance and a weight for weighing two or three of the largest fragments of each heap of broken stones, to ascertain that none exceed the specified weight.

In order to construct or repair a road, says the inventor of the plan which we are now describing, a layer of solid materials of ten inches in thickness, is sufficient. This road will be capable of bearing all sorts of loads; whether the soil over which it is made be firm or not. Mr. M'Adam even prefers a soil consisting of a mixture of hard and soft materials to a perfectly hard soil. He observes, that on the former, the roads are least liable to wear; because they rest on an elastic bed which yields to very heavy pressure, and deadens violent shocks. On the same principle, an anvil laid on a block of wood, will last longer than if laid on a stone.

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* In Sweden, where the roads are very fine, they are made of granite broken into fragments, none of which exceed the size limited by Mr. M'Adam. Edgeworth proposes, that all the pieces of stone should pass through a circular calibre of an inch and a half in diameter.

The following very remarkable example of this difference may be mentioned. The road from Bridgewater to Cross is partly made over a moveable morass, so that when travelling along it in a coach, one may see the water, trembling in the ditches on each side. After a slight frost, the quivering of the water, occasioned by the motion of the vehicles on the road, is so violent as to break the ice that is formed on the surface of the ditches. Adjoining the portion of the road made upon this marshy ground, is another part made on a bottom of calcareous stone. The expense of keeping in repair these two parts of the road is in the proportion of five to seven, though that part which is carried over the hard soil lies higher than the others.

Even in making roads on a marshy soil, Mr. M'Adam does not recommend the use of fragments of stone weighing more than six ounces, without on that account rendering the road any thicker. He affirms that it will not sink into the soft soil, because, says he, the elements of which the road is composed unite together, and form a great, compact, and solid mass, which has no tendency to sink in one part more than in another. The thickness of the bed of materials, which he would then propose to lay down, would vary only from seven to ten inches. According to Mr. M'Adam, five tons of broken stones laid in this way, on a marshy bottom, make as good a road as seven tons of stones laid on a very hard bottom. Unfortunately, experience, instead of confirming this specious theory, has served only to prove its error.

The most distinguished engineers in Great Britain, have eagerly adopted Mr. M'Adam's general plans; though they do not concur with believing that the practice, hitherto observed, of laying down a bed of flat stones or faggots of wood, may be dispensed with.

In repairing some parts of the road leading to Ireland, in places remote from quarries of hard stone, Mr. Telford has introduced a plan by which all the gravel that can be procured may be rendered useful, and which gives the utmost solidity to those parts of the road which are most frequented. The following table shews the place occupied by each lower layer, and by each fraction of the upper layer. The width of the road is

Thickness of the layers.	Siftings of Gravel.	Small Gravel Stones.	Large Gravel Stones, broken.	Large Gravel Stones, broken.	Small Gravel Stones.	Siftings of Gravel.
3 inches.	3 feet.	4 feet.	8 feet.	8 feet.	4 feet.	3 feet.
3 inches.	Layer of Lime.					
6 inches.	Layer of Gravel.					
6 inches.	Layer of Lime.					
	Clay serving as a foundation for the Road.					

In places where the foundation of the road is not very firm, Mr. Telford deposits a first layer consisting of stones placed closely together, their broadest side measuring nearly five inches, being laid downwards. Above this layer is placed, according as the nature of the situation may require, either well washed gravel, or stone broken into fragments. A second layer, nearly six inches in thickness, is formed in the same way.

In some parts of Wales, scoriæ, procured from the furnaces of iron foundries, *&c.*, and ashes, obtained from the stoves of steam-engines, are used instead of gravel and fragments of stone. These calcined materials form roads no less firm than durable.

In certain parts of England and Ireland, where there is a want of good materials for road-making, clay baked like brick, and afterwards broken into fragments, is employed for that purpose. But this custom must necessarily become more and more rare, in a country where fuel is exceedingly expensive.

It is of the utmost importance to raise the ground over which the road is laid, in places which are subject to inundations or great damps. The English have executed several works of this kind, which are well worthy of attention. For example, the Holloway road has been raised between six feet and a half and ten feet over a length of about six miles. This work, vast as it is, was executed by a trust.

In laying out roads on marshy or soft ground, it is necessary to adopt every possible means of draining them, by digging deep ditches on both sides, in a direction parallel with the road. At least one year should be suffered to elapse, to afford these ditches time to produce their due effect, before the road-works are commenced. If the foundation be very marshy it will sink considerably by the draining; and this sinking will be more or less in different places, according to the nature of the soil, and the depth of the marsh. The cavities and hollows are filled up; and as much turf as can be procured in the neighbourhood is laid down over the foundation thus prepared. The horse-road is covered with a layer of sand, or any other similar material, through which water may pass. This layer, which is from ten to twelve inches in thickness, is pressed down with the roller, and the road is thus finished. If the ground be not at first sufficiently hard to bear the weight of horses, men are employed to drag the roller.

Mr. Patterson recommends that the following method should be observed in laying out a road on a very damp soil, or in a situation where the ground is liable to be inundated by springs. A ditch should be dug, as narrowas possible, and from two to three feet in depth, running along the middle of the road. This ditch should be filled with stones up to a level with the surface of the road; the stones at the bottom being about six inches in diameter. From this principal drain there should branch out, at intervals, subterraneous drains, constructed in a similar way, to carry off the water into the ditches at the sides of the road.

In some places the subterraneous aqueducts for keeping the roads dry are made in the following manner:—after digging to the depth of from four to eight feet, a layer of faggots of brambles, two feet in thickness, is placed at the bottom of the hollow; above this is laid stubble or turf, and the whole is covered over with a layer of earth. These aqueducts are nearly three feet in width, and they last for the space of twenty-five years.

In some parts of England, when a road is made upon a marshy soil, it is customary to plant branches of willow closely together, between the ditches and the road, in order to strengthen it in those parts, and to prevent carriages, &c., from overturning into the ditches. This plan perfectly answers the purpose for which it is intended.

CHAPTER V.

Repair of Roads.

In the preceding chapter we have shewn that the roads of Great Britain do not owe the high reputation they have so long enjoyed, to any qualities of soil or climate favourable to their preservation; for in those parts of Great Britain where the soil is least advantageous, and where the intemperance of the season is most severe, the roads are in as good conditions as in places where nature has been lavish of her gifts. The quality of materials, though doubtless an important point, is not the essential cause of the superiority of the public roads in Great Britain; for even in places where the traveller is most struck with this superiority, the materials are least suitable for the construction of good roads.

Surely it will not be said that England possesses materials preferable to those of any other country for constructing edifices, ships, carriages, and machines, and yet in England all these things present an appearance of newness, neatness, and even beauty, which is only observable in a partial degree, and among a very few of the other nations of Europe. It is with works of every kind as with the roads in England; the constant appearance of perfection which they exhibit must be attributed to the unremitting attention which is bestowed on their repair.

On this point a great question of public and domestic economy presents itself. Is it advantageous either to the state or to private individuals, for the preservation of objects of any kind, to adopt the method of making considerable repairs at long intervals? Is it, on the contrary, better not to wait until decay be far advanced, but to repair daily the injury occasioned by the perpetually destroying hand of time?

Independently of every other consideration, it appears to me possible to prove, by mere calculation, that in the long run, the plan of constant and careful repair costs less than the plan of vast repairs, executed on works which have long since been rendered imperfect, either by use or by the natural effect of time.

It is remarkable that the most economical nations, and those who best understand their pecuniary interests—for example, the Dutch, the Swiss, and the English, adopt, with universal accord, the plan of keeping up constant repairs*. On the contrary, people who are less calculating and provident, as, for instance, the Italians, Portuguese, Spaniards, *&c.*, usually wait until a thing is gone to ruin before they set about repairing it. In different parts of France, according to the character of the inhabitants, and the degree of advancement they have made in industry or domestic economy, we may observe differences analogous to those which we have just pointed out as existing in the several nations of Europe.

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* In the two first parts of the present work, entitled *Military Power* and *Naval Power*, and in the memorial on the Progress of Naval Architecture in England, published by the Royal Society of

In addition to these general considerations, it may be remarked, where the plan of constant repair is adopted, all buildings, public works, and machines present an appearance of freshness and solidity, which bears evidence of the wealth, regularity, and prudence of private individuals and the government.

When, in my travels in England, I visited those places in which the coal smoke does not blacken the walls so as to give them very soon the semblance of age, I was always deceived by appearances. The exterior of the buildings seemed so perfect and so seldom exhibited those traces of decay which, in all other countries, reveal the old age of structures, that I fancied all the edifices I saw had been recently built; and I was not a little surprised when I came to be informed of their real age.

London, I have endeavoured to show that the plan of constant repair, adopted with respect to military structures, arms, and ships, is to be preferred for the sake of utility and economy.

It must be acknowledged that this careful system of repair does not produce, in the architecture of a nation, those picturesque effects which a lover of the fine arts admires in the partial decay of buildings and public monuments. In England, the works of nature and art are kept perfectly distinct from each other. Thus vegetation, which is so luxuriant in the fields, *&c.*, is rigidly proscribed on the walls, on the roofs, and even round the windows of Gothic edifices. Excepting a few remnants of churches and monasteries, the last vestiges of a faith which has been abolished for three centuries, there are in England scarcely any ruins, save artificial ones, raised on well mowed lawns or carefully sanded terraces. These tottering structures are erected with no less solidity than a family mansion; and no less attention is devoted to their repair than to their construction. The spectator need feel no apprehension on the score of these ruins; he may be assured that they will always present the appearance of decay in the same degree.

But however amusing it may be to contemplate this perpetual conflict between the attacks of time and the resistance of man, it is still more interesting and important to observe, that in Great Britain, buildings, machines, and instruments of every kind, are kept in so perfect a condition, as to be at all times fit to answer the purposes for which they were originally created. Thus it is, that throughout all England, with the exception of a few districts, where great obstacles are to be surmounted, the roads are now kept constantly smooth and firm. Hence arise a saving of expense and a degree of regularity, which are very advantageous to trade and to the public service. The smallest possible number of horses, drivers, and carriages, suffice for the conveyance of travellers, *&c.*, and this very economy, by the facilities and advantages it presents, serves to augment the traffic on the public roads.

Independently of the great annual repairs for renewing the materials when worn out by friction, and for elevating the road when it sinks by pressure, the roads in England receive continual attention from workmen who are kept constantly employed at different parts of them. In winter, when the rains and fogs convert the pulverized materials into a thick and heavy mud, this mud, after being scraped from the middle of the road, is heaped up along the sides and afterwards carried away. It is often used for manuring the neighbouring fields. New materials are not laid down on the road, nor are the ruts which may begin to appear filled up, until after the dust and mud have been carefully removed*.

During a great part of the year the damp climate of Great Britain keeps the roads in a state of humidity which operates very much against their preservation. We mentioned in the preceding book, that the law has provided measures for removing from the sides of the public roads, the trees which may intercept the rays of the sun, or impede the free current of air, so useful for drying the roads in damp weather, and sweeping away their dust in time of drought.

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* The mending of the road should take place immediately after the removal of the mud, and while the ground is still impregnated with water.

Though a degree of damp merely sufficient to form slimy mud, and to soften the solid substances which lie beneath this mud, is found to injure the roads, and to impede the rapid passage of wheeled vehicles; yet, on the other hand, an abundant supply of water produced by heavy rain, or by artificial means, is considered to be useful, not only as affording facility to driving, but as tending to preserve the road. When the road is thoroughly washed, the mud is carried off in winter, and the dust in summer. At the expiration of a few hours, even after a succession of rain, the road is found to be dry and perfectly firm.

Some roads are irrigated during summer, for the purpose of laying the dust with which they are covered, and which would become mud in rainy weather. It has been proposed to adopt the same method after frosts, and when the atmosphere is impregnated with damp. When the substances pulverized by friction have been thus moistened, it is very easy to sweep or scrape away the fluid mud that has been formed, and which has not a run off of itself.

Hitherto the English have by no means pursued the best methods for keeping their roads in good condition. They have, in consequence, found it necessary to expend enormous sums of money*, But by means of these sacrifices, the object they were intended to fulfil has been effected, though by following imperfect methods.

To afford an idea of these expenses, it will be only necessary to present an account of the annual revenue and debt of each trust in a road of upwards of 150 miles long. The amount of the debts will shew that the revenue, enormous as it is, is not sufficient to cover the repairing expenses. (See 6th Report of the Commissioners of the Road from London to Holyhead, made in the year 1819.—Appendix, p. 132.)

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* Some idea of the amount of the money expended in this way may be formed from the following particulars, furnished by Mr. Walker, the engineer of the Commercial Road, which leads from the City of London to the East and West India Docks. (See the Report on Roads, made by the Committee of the House of Commons, in 1818.) "On examining the turnpike-roads in the vicinity of London," says Mr. Walker, "I found that the materials employed in repairing them seldom remain on the ground more than a month or six weeks in winter, before they are reduced to powder, and then swept from the road. In summer, fresh gravel is laid down on the middle of the road, and then dispersed over the sides. This very well answers the purpose of preserving the roads until the rains of winter convert this pulverized gravel into a kind of mud, which is speedily transformed into an imperfect fluid, and is scraped away. It is necessary that this work should be continually repeated, so that carts bearing loads of eight or ten tons may not pass over substances which are incapable of bearing such a weight. If this method be not adopted, brick, and even the hardest stones would soon be reduced to powder.} It is not surprising to find," adds Mr. Walker, "that the annual repair of the roads in the neighbourhood of London cost nearly 1,000*l*. per mile. The road managed by Highgate trusts, which is twenty miles long, requires, to keep it in good condition, an annual supply of 10,961 loads of material, at six shillings per load.

TRUSTS.	Miles on post roads.	Number of miles in each trust.	Debt.	Interest.	Tolls.	Neat revenue per mile.
			£.	£.	£.	£.
1. Shrewsbury District of Watling	7	7	4,050	202	705	72
2. Wellington do. and its branches	7	21	1,900	95	1,305	58
3. Shiffnall do. and its branches. . .	4	10¼	240	12	650	62
4. Wolverhampton and its branches	14	26	3,856	193	1,710	58
5. Bilston and Hednesbury	3¾	11	2,523	126	1,242	111
6. Hednesbury, Birmingham, and their branches	7½	44½	2,900	145	2,085	134
7. Birmingham and Stonebridge . .	8¾	8¾	6,517	326	1,299	111
8. From Stonebridge to Dunchurch.	19	19	300	15	1,687	88
9. From Dunchurch to Old Stratford	29	29	5,000	250	3,563	114
10. From Stratford to Hockliffe . . .	14	14	1,200	60	1,743	120
11. From Hockliffe to Dunstable . . .	4¼	4¼	6,040	302	2,205	448
12. Dunstable and Shafford House . .	12	12	5,100	255	1,940	140
13. Saint Albans and South Mims . .	11½	11½	5,972	298	2,510	192
14. Whetstone	8½	8½	2,100	105	3,820	437
15. Highgate and Hampstead	4	20	7,900	395	11,536	557
	154¼	216¾	55,603	2,779	38,010	

Mr. M'Adam, of whom we have made mention in the preceding chapter, has been no less successful in his methods of repairing and supporting roads, than in his plan of constructing them. He has formed a correct idea of the connexion which must exist between these two branches of road-work. He observes, that a road which has been originally well made will always be easily kept in repair. It will never become either soft or rough. The materials with which it is covered will, of course, wear thinner by the friction of the wheels, but the road will still be in good condition. It will only be necessary to add, from time to time, a certain quantity of material, prepared in the same manner as that which was employed in making the road. Between the first construction of the road and the great periodical repairs, no other expense will be incurred, except such as may be necessary for keeping the rain-water drains in good condition, and for rectifying any accidental damage that may occur, independently of the wear and tear occasioned by the continual friction of the wheels. If these methods be adopted, adds Mr. M'Adam, trusts will no longer be burdened with the continual expense occasioned by vain and repeated efforts to improve the public roads.

We subjoin an analysis of the instructions drawn up by Mr. M'Adam for repairing roads which have been constructed on the old plan. The same instructions may be followed in France, whenever we may set about improving our roads. They were published along with the Report relative to Public Roads, made by a Special Committee of the House of Commons, in 1811. Since that period experience has enabled Mr. M'Adam to bring his plans to perfection.

Every road should be made of broken stones, without any mixture of clay, lime, unctuous earth, or any other substance which powerfully retains damp, or which is liable to decay by the effect of frost. Nothing should be thrown over these stones with the view of making them adhere to each other. They will, by combining their angles and joining their flat sides, form a compact whole, and present a smooth and solid surface, which cannot be injured by any variations of the atmosphere, or disfigured by the action of the wheels, which will roll over it without jolting, and consequently without experiencing or occasioning the least damage.

It is not necessary to repair one of these roads until the layer of stones of which it is composed, be reduced to less than nine inches and a half in thickness. The large stones that may adhere to the old surface must be taken out, and dragged to the sides of the road: for this purpose, a strong rake is used with teeth nearly three inches in length, and the same instrument serves to spread the stones equally over the road. A proper form is given to the profile of the road*. These preparations being ended, and the large stones collected along the sides of the road being reduced to fragments of six ounces in weight at the most, they are spread over the surface which they are intended to cover. On this operation depends, in a great measure, the goodness of the whole work. Each shovel-full of stones which is laid down on the road, should be spread over a considerable space; and therefore the shovel-fulls are thrown down at a considerable distance from each other. The road should not be repaired all at once, but by separate portions, each portion measuring not more than about seven or ten feet in length. The work is executed by a party of five men, stationed abreast, and occupying the whole width of the road. Two of these men rake out and range along the sides of the road; the large stones, which are afterwards broken by the others. As soon as they are broken, they are carefully spread over the portion of the road above-mentioned prepared to receive them*. This portion of the labour being ended, the next is begun.

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* When the road is completely repaired, the convex curve which its profile presents, should not have a greater rise in the middle than three inches over a width of about thirty feet, which makes, as we have observed in ch. 2 of the present book, one-120th,

If the materials of the old road contain gravel mixed with earth, they must be carefully sifted, for the purpose of separating the earth.

In order to cover with broken stones a road which is firm, but worn out by use, the surface of the road, which has been hardened and smoothed by the friction of wheels, should be raked up and well cleaned. This process facilitates the adhesion of the new materials with the old ones; on the same principle, a stone wall is chiselled out before a fresh coat of plaister or cement is laid on.

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* There are, however, some exceptions to these rules laid down by Mr. M'Adam. For example, the road from Bath to Cirencester was composed of stones which were too large, and which it was found necessary to break into smaller fragments. But the stones were so friable, that they were pulverized by the strokes of the hammer. To repair this road, Mr. M'Adam recommended, that all the rough parts should be levelled, and the surface made perfectly smooth; then, that the materials which composed the old road should be worn out by the friction of the wheels, and afterwards replaced by a better kind of stone properly prepared. In the Bath district, a portion of the road was paved; and there would have been no advantage in taking up the pavement, and making the road on a new plan. At Egham, in Surrey, it was found necessary to take up all the materials composing the old road, in order to separate from them the small portion which was sufficiently solid to be employed in making the new one. This preliminary operation was certainly expensive; but it was the only expense incurred in substituting an excellent road for a very bad one.

Until a road thus repaired acquires a certain degree of firmness, ruts, more or less deep, will be made on it by the passage of the wheels. To remedy this defect, an attentive labourer should be employed in filling up the ruts for some time after the first repair of the road*.

The heaviest stones are first broken into large pieces, and ranged in heaps to be afterwards chopped into fragments, not exceeding six ounces in weight. This last operation is performed by women, children and men, incapable of bearing fatigue. They seat themselves on the ground, and break the stone with light hammers.

The use of light hammers, and the easy position assumed by the labourers, has occasioned a reduction in the payment of breaking stone. To reduce a ton of large stones into fragments not exceeding six ounces in weight, now costs no more than ten pence or one shilling. It was customary to pay half as much again†, or even twice as much‡, for breaking large stones, according to the old plan of road-making, into pieces of twenty ounces, than is now paid for breaking them into small fragments of six ounces. People are very eager to be employed, even at this reduced price, for the labour with heavy hammers being performed by men, and that with light hammers being easily executed by women and children; this division of the work enables whole families to find employment.

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* It will be interesting to know the expense of the labours which we have just described. For repairing a rough road, breaking the large stones which occasion unevenness, laying down the broken stone, clearing the drains, in short rendering the road the same as new, the expense varies from one penny to two pence per nine feet square. This variation of expense depends on the quantity of stone which it is necessary to break.

† In the neighbourhood of Bristol.

‡ In the county of Sussex.

In Mr. M'Adam's enumeration of the advantages of his system, he observes that the quantity of stone necessary for the roads is diminished. This is a considerable saving of expense, particularly with regard to the horses and carts employed in conveying. The chief portion of the sums expended on the construction and repair of the roads, is now paid to labourers of every age and of both sexes*.

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* For example, in the district of Bristol, the repair of the roads, which formerly cost three times more for the labour of the horses than for the labour of the workmen, now cost three times less. It has been proved by correct accounts, kept for the space of six months, that during that period, 3,088*l.* have been paid for the labour of men, women and children; while only 1,025*l.* have been paid for the labour of the horses. (See M'ADAM's *Remarks on the present System of Road-making.*)

CHAPTER VI.

Wooden and Iron Rail-Ways.

Under the name of rail-ways, I include all roads on which wheeled vehicles move along rails, disposed in such a way as to facilitate the draught.

Wooden Rail-Ways.

These roads were at first used for the conveyance of coal and ore, both within and without mines. So early as 1671, wooden rail-ways placed longitudinally on transverse slopes, were employed in the neighbourhood of Newcastle. In France, wooden rail-ways are still used in the coal mines of Auzin, and in the lead mines of Poullaouen. We might apply this plan to many important purposes—for example, for the conveyance of timber for ship-building, when it is too far removed from water-courses to be transported by the usual means.

Iron Rail-Ways.

The general improvement of manufactures in Great Britain, which has occasioned iron to be substituted for wood, in a multitude of ways, has given rise to the use of iron rail-roads. They were originally introduced in the great foundery of Colebrook Dale, about the year 1786. The first idea of this improvement is attributed to Mr. John Curr, civil engineer of Sheffield. Mr. Jessop was the first engineer of celebrity who made use of iron rail-ways in the south of England.

We have already shewn the advantage derived from the use of these rail-ways by land and by sea, for the conveyance of the materials employed in constructing the Plymouth Breakwater. (See *Force Navale.*) In treating of commercial conveyance, we shall notice many other uses of these rail-ways, no less advantageous and interesting.

At the time of my first visit to Great Britain, it was calculated, that in the neighbourhood of Newcastle, there were two hundred and twenty-five miles of iron rail-ways along a space of twenty-one miles long, and twelve broad above ground; and those below ground were not less extensive. In Wales, iron rail-ways are very much used for conveying ore and coal from the mines to the furnaces, and iron and coal to the canals and ports. The rail-way from Cardiff to Mertyr-Tydwil, is thirty-six miles long. In Glamorganshire alone, there are three hundred miles of rail-ways.

The rail-ways in Scotland are highly important, as well on account of their extent as for the advantages they afford to trade: such, for example, is the road from Kilmarnock to Troon. Next to this, the most remarkable are the rail-ways of the Carron iron-foundry, and of Lord Elgin's, Mr. Erskine's, and Sir J. Hope's coal mines. A plan has been proposed for making a rail-way from Berwick to Glasgow, along a line of one hundred and fifty miles: the execution of that part of the road lying between Berwick and Kelso, is already authorized by act of parliament.

There have been numerous suggestions for making iron rail-ways in the neighbourhood of Edinburgh. It has been proposed to connect the capital of Scotland, by a well-arranged plan of rail-ways, with the counties of East Lothian, Berwick, Roxburgh, and Selkirk: this would be attended with immense advantages to the agriculture and trade of the Lowlands. Mr. Robert Stevenson is the projector of most of the plans of this kind, which for some years past have been proposed for the adoption of capitalists. Many of these will no doubt be carried into execution. The reports which explain these plans, together with the circumstances on which they are grounded, are highly interesting from the numerous facts and hints which they contain. We take this opportunity of expressing our gratitude to Mr. Stevenson for the very obliging way in which he communicated his plans to us: his civility has only been equalled by that of our friend Mr. Telford.

In treating of conveyance, we shall enter into many details relative to the construction of the wagons which are used on iron rail-ways.

Laying out of Rail-Ways.

Though rail-ways are always laid out on the same principle, yet they may be considered under two points of view essentially distinct: 1st, when there is conveyance in one direction only; 2d, when conveyance takes place in two opposite directions.

In the first case, the most simple method is to raise vertically, by the help of machinery, to the summit of the inclined road, all the loads which are to be conveyed. The wagons have then only to descend from the summit.

When it is only necessary to descend, in order to convey loads to rivers, canals, or high roads, whatever be the distance, the conveyance may be advantageously effected by the help of well-constructed rail-ways. In this manner, rail-ways might be employed in France with the best success, for the conveyance of timber for ship-building, *&c.*, in situations which are so high, and so remote from any river, that timber cannot, without too great an expense, be conveyed by ordinary roads to water-courses, along which it may be floated. This is an object of the utmost importance to our naval power, our maritime trade, and various other branches of our national industry.

What is the most advantageous degree of inclination for rail-ways? That which enables loaded carts to be set in motion by the mere effect of their weight. A horse, drawing a file of carts along this declivity, has only to exert the degree of strength necessary to overcome the inertness of the mass he has to drag, and the little impediments occasioned by any slight roughness of the road.

The number of loaded carts which a horse is able to draw, is equal to the greatest number of empty carts which the same horse can draw back again along the same road. Thus, the greater the inclination of the road, the horse has the fewer carts to draw down at each journey. Hence it is evident, that there is a certain degree of inclination more advantageous than any other; namely, that which requires all the strengh of the horse, either in ascending or descending. The heavier a cart is, the less is the degree of declivity along which it will descend of itself, and the greater is the number of empty carts which the horse is able to draw back again up the ascent. In this point of view, there is a great advantage in employing large carts. Those used in the neighbourhood of Newcastle, which carry sixty hundred weight, and weigh thirty-six hundred weight, are preferable to those used in the vicinity of Glasgow, which carry only seven hundred weight, and weigh about three and a half.

On a well-constructed horizontal road, a good horse may draw as much as nine tons.

In places where the declivity is greater than is necessary to set the carts into a regular and moderate degree of motion, the motion is checked either by a bridle, or by a retarding system, which we will describe in treating of conveyance on iron railways.

Inclined Planes.

This is the name given to those parts of roads, where the declivity being very great, renders the aid of machinery necessary to make wagons ascend and descend. The construction of these inclined planes is similar to that of other parts of rail-ways.

According to the principles which have just been laid down, a horse employed in descending an iron rail-way on an inclined plane must exert his whole strength to draw a certain number of wagons back again up the ascent. If the nature of the ground render it necessary to vary the inclinations, this should be done in such a manner, that each declivity may be suited to the movement of a certain number of wagons. The rail-ways should run in right lines, forming rectilinear polygons; or in curved lines, each having the same degree of declivity throughout its whole length. The various degrees of inclination which should be given to the road may be best decided by experiments.

To save the loss of time occasioned by useless harnessing and unharnessing, it is only necessary to give to each part of the road, presenting an uninterrupted slope, such a degree of length as to form a relay. The number of horses employed in the conveyance should be in an inverse ratio to the number of empty carts which they are capable of drawing up the ascent, and to the time they occupy in passing from one relay to another, either in going or returning. By this means, the same number of carts will move along all parts of the road in the same space of time, and the horses and drivers will never be obliged to wait for those which follow or precede them.

In laying out rail-ways, it is necessary to avoid ascents and descents, except, of course, where local circumstances render them unavoidable. To save the labour of ascending and descending, light and strong wooden bridges are often thrown across narrow and deep valleys; these bridges have a horizontal platform, over which the rail-way is carried. Rail-ways may also be carried over bridges suspended by iron chains*.

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* Mr. Stevenson has suggested a plan for crossing the narrow and deep ravines intersecting the line of rail-road which he has proposed laying out. This plan consists in placing the wagon on a suspension frame-work. The frame-work would advance, by means of pulleys, along an inclined plane composed of chains or bars of iron, extended from one side of the ravine to the other.

Travellers, in crossing the small river in Peru, are placed in a basket suspended by a long rope, which is drawn from one bank to the other. This practice exists at Noss-Holm, one of the Shetland Islands; and at Carrick-a-Ride, near Ballintoy, in Ireland, In places where the ground presents only gentle rises and falls, level roads, or relays of continued slopes, may be made according to circumstances, 1st, by judiciously levelling the ground or filling up the hollows, so as to shorten the length of the road; 2ndly, by making general turnings and windings corresponding with the lowest expense in the construction of the road, so as to secure for conveyance the advantages previously calculated. In this respect the principles are the same relative to the construction of all kinds of roads.

A peculiar feature of rail-ways for conveying loads in a straight direction is, that by means of an inclined plane, carts may be suddenly raised to a height, whence they have only to descend, moving along the gentlest possible degree of slope, to return to the point from which they started. In the second section of this part we shall prove, numerically, the advantage of the plan here alluded to.

If the total amount of conveyance be the same in going and returning, the declivities must not be so arranged as to be more favourable in one direction than in the other. The only objects which it is important to effect, are, the lowering of elevated points, and the diminishing of the steepness of declivities, but without rendering the road too long or too ex-

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the same method is followed in crossing a very deep bog. Mr. Stevenson suggests that the plan might be adopted for the purpose of drawing a frame with loaded wagons across the river Esk.

pensive. In general, two rows of rail-ways are made to run parallel with each other; the one is used for going to the destined point, and the other for returning from it.

We will now describe the structure of iron rail-ways. They are divided into two kinds, according to their form. The tram-ways, or plate-ways, are made of plat-bands of cast iron. They have a projecting edge at top, which runs along the outside of the rail; at bottom, a run gives to the plat-band the strength necessary for supporting the weight of the wagon wheel, which runs flatly in the groove. The edge-ways are formed of pieces of iron laid flat on the ground, and rounded on their upper side; the wagon wheel has a groove like that of a pulley, which fits to the round part of the rail-way. The tram-ways have the disadvantage of considerably augmenting the friction, in consequence of the earth, dust, sand, and gravel, which lodge in the hollow of the rail. The edge-ways are exempt from this inconvenience. When equal in all other respects, they are capable of bearing a more considerable weight, and they are consequently employed in preference, in places where extensive conveyance is necessary. They are very much adopted in Wales. In the neighbourhood of Newcastle the tram-ways are still generally used.

Near the village of Brompton, nine miles from Carlisle, there is a rail-way of wrought-iron, which leads to the coal-mines belonging to the Bishop of

Carlisle. It is the first of the kind that was made. The use of wrought-iron rail-ways was not introduced till 1813.

The edge-ways are formed of bars of wrought iron, about one inch and a half in width; the vertical thickness, which is always greater than the width, is proportionate to the weight which the rail has to support. The edge-way not only occasions less friction, but it is capable of supporting a heavier load, than the train-way, both on account of its form, and because it is made of a less brittle substance.

Mr. Stevenson recommends the making of edge-ways capable of bearing two tons, including the weight of the cart; the iron employed in constructing such a road should weigh one hundred and thirty-two pounds for every three feet of the double rail-way. Smaller dimensions would, in case of emergency, be sufficient; but the rail-ways on a public road should be made stronger than is strictly necessary. By this means, the expense of frequent repairs is avoided, without any increase of labour in the original construction of the road.

M. Gallois states, that it is sufficient to make each bar of iron, composing the tram-way, four feet in length*. Two bars and their supports weigh from one hundred and ten to one hundred and thirty-four pounds for edge-ways intended for great carts. In tram-ways, for the passage of small carts drawn by horses, they should weigh seventy pounds; and if the conveyance be made in carts drawn by men, the weight of fifty pounds will suffice.

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* This dimension, and all the rest, vary, according to local circumstances and the nature of the conveyance to be made along the road. For the following particulars, I am indebted to M. Gal-

The laying down and fixing the rail-ways are essential points. It may easily be supposed, that through bad management, or any defect in the soil, some of the supports will sink to the depth of half an inch, merely by the passage of the wheels of loaded carts. In these parts, the bar of a rail-way will be very likely to slope one *sixtieth*, and consequently the drawing of the carts will require *double* the degree of force which was employed when the road was horizontal.

The plan of iron rail-ways, in spite of the great advantages of which it is susceptible, produced no

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lois, who is the author of a very interesting memorial on iron rail-ways. The bars laid down for the edge-ways, are two feet eleven inches long, and one inch and one-third wide. They are laid on traverses of wood or cast iron, and these traverses are raised and supported on blocks of masonry. The bars of which the tram-ways are formed, are four feet in length, and three inches in width (*a*), in the part along which the wheel runs; the thickness of this part is a little more than half an inch. The edge is two inches and one-twelfth in height, and one-third of an inch in thickness.

(*a*) There is in the original 0 m.,8 for the width of these bars, which would make two feet eight inches English measure. We suppose it is a mistake, and that it ought to be 0 m.,08. (*The Translator.*)

positive benefit on its first introduction, because the means of surmounting the difficulties above alluded to were not known*. Vast sums were uselessly expended; because the rail-ways were laid upon supports of soft and friable stone, which, being placed on the surface of the ground, were exposed to all the variations of the atmosphere.

To obviate this defect, the rail-ways were subsequently supported on transverse bars of cast-iron; the ends of each piece of the rail-way being fastened on the extremities of these bars.

It appears, that rail-ways of wrought iron are found to be much better than those of cast-iron; for the former are not, like the latter, liable to break when the cart-wheels pass over any little stone that may happen to lodge in the groove of the rail. For the last eight years, a rail-way of wrought-iron has been used for the works of Tindall Fell, in Cumberland, where there are also two cast-iron rail-ways. The former is found to be the best in every respect; and it has also proved to be the cheapest in its construction and support. In Scotland, comparative experiments on the same subject have led to a similar conclusion.

Mr. Stevenson, in one of his plans, makes the following calculation of the width requisite for a double iron rail-way:—

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* It is likewise proper to observe, that the nature of the ground has a great influence on the solidity of the rail-way.

	ft.	in.
Width of the rail-way intervals each 4ft. 3in.	8	6
Width between the two rail-ways	4	0
Width on each side for the driver's foot-path, the path, the drains, the posts, *&c.*	7	6
Total	20	0

The rail-way intervals may be covered with small fragments of stone, with a layer of gravel above them. The path for the drivers may be consolidated, according to local circumstances, with gravel, scoriæ, or coal, *&c.*

There is a third kind of iron rail-ways, which are quite flat, without edges or rims, and which are laid into hollows made in the common road or pavement, so as not to rise above the level of the ground. This plan is particularly well-adapted to the streets and squares of a town, where vehicles of all forms and sizes are continually passing in every possible direction. These rail-ways have been made in Glasgow, on the great declivity leading to the basin of the Forth and Clyde Canal, on Port Dundas. In ascending the rail-way along this slope, a good horse may draw as much as three tons, and may daily work with the weight of a ton and a half.

It has been proposed to make the flat rail-ways, just described, on high roads, particularly along very steep declivities. This would obviate the necessity of employing additional horses, or of partly unloading wagons on arriving at these sloping parts, which would occasion no greater drag to the horses than a horizontal road.

Would it not be advantageous to lay down these flat rail-ways along one side of the very sloping streets of our great towns,—for example, in several of the descents of the Hill of St. Geneviève, in Paris. They might be used by vehicles ascending, while those descending might pass along the common pavement.

Expense of making Iron Rail-ways.

This expense must vary according to the price of the metal. This price being comparatively low in Great Britain, the plan of making iron rail-ways presents, in that country, relative advantages, much more decided than in France. Thus, all things else being equal, the English naturally possess more iron rail-ways than the French, and derive greater advantages from them.

In those parts of France which are situated near iron-mines, where there is little pasture, and where consequently the feeding of draught cattle is expensive, iron rail-ways would be found particularly useful. Important results may be anticipated from that which is about to be made for conveying from St. Etienne to the Banks of the Rhone, the produce of the mines and manufactures of that town, which bids fair to become the Birmingham of France. This rail-road will impart a fresh impulse to the industry of the fertile valley of the Rhone, by supplying it, at a cheap rate, with those two great supports, the manufactures of coal and iron.

In every district, the most judicious mode of procuring, is to calculate the comparative expense of making and supporting a common road and an iron rail-road; and next, the comparative expense of conveyance on both roads, in order to ascertain which of the two plans requires the lowest amount of capital. Similar calculations should also be made relative to the question of choosing between a canal and an iron rail-road. Rail-roads are not only advantageous in point of economy, but they are serviceable in all seasons; they are not injured by frost, filtration, or inundation; and they may be made either above or below ground, in districts where the soil is dry, without occasioning such a consumption of water as would withdraw too much of it from agricultural purposes.

BOOK IV.

WORKS RELATING TO INTERNAL NAVIGATION.

CHAPTER I.

General System of Internal Navigation.

In England, nature herself has greatly facilitated internal navigation. A climate moderately warm, and the west winds which prevail through the larger portion of the year, always bringing with them thick mists, and often heavy rains; both combine to increase the quantity of fresh water, and to diminish its evaporation. To the same causes ought we to ascribe the prodigious number of torrents and rivers which, as it were, furrow the surface of Great Britain.

This island is shaped like a lengthened triangle, the base of which lies towards the south, and the top towards the north: a great chain of mountains runs parallel to the western side; and a secondary chain stretches along the southern base, and approaches very near to it. Thus the streams on the south have but a trifling depth, and furnish currents of no great importance, whilst the rapidity of their fall unfits them for the purposes of navigation. The most considerable basins, and those which furnish the largest streams, empty themselves towards the eastern coast; such as the Thames, the Wash, the Humber, the Forth, and the Tay.

The streams which run from the west to the south are very short and rapid; those towards the north are much deeper: thus the considerable rivers, like the Mersey, the Clyde, *&c.*, are all on the north-west coast of England. The magnificent basin of the Severn is the only exception to these general observations; this stream, which runs, for nearly its whole length, in the same direction with the principal chain of mountains that skirt the western side of England, receives the waters of a great number of shallow valleys which lie on either side of it in England and Wales.

This is a brief view of the resources which nature has supplied for the internal navigation of Great Britain. We must now examine the manner in which art has increased these resources, and profited by these situations.

We shall not attempt to present a complete view of all the hydraulic works which have been executed on the larger rivers, streams, and canals of England and Scotland: the immense details necessary in such an attempt would require a great number of volumes. Our object is merely to make known the system of these works, so far as it is favourable to commerce, and the other branches of public prosperity. Without stopping to describe an innumerable quantity of works of art, constructed on the same principles, with the same means, applied to the same obstacles, and productive of the same results, it will be sufficient for our purpose, if we select from them those labours only, which exhibit some novel conception, or some remarkable difficulty skilfully overcome. Thus, we shall give no description of the weirs, nor of the locks built on streams, to render them navigable in the higher parts, as these are well known to most of the continental nations; our attention will be wholly confined to the system of artificial navigation, which, combined with the natural navigation, contributes so powerfully to the prosperity of Great Britain.

The earlier attempts to improve the navigation of the streams in their natural state, remedied very imperfectly the difficulties which existed; alluvial sand-banks formed themselves beneath the weirs; the rivers, whose primitive condition had been altered, were rapidly changing the form of their channels; and the dykes and other constructions upon their banks were frequently destroyed by inundations. It was always a long and difficult work to ascend their streams by means of towing. These obstacles first suggested the idea of abandoning the natural channels of the smaller rivers, and of digging, in parallel directions, artificial channels, in which the water might be kept at the proper level by means of locks.

Montaigne has been much admired for his ingenious definition of rivers, when he said they were *moving roads*. These moving roads are, no doubt, a very great advantage, when we can travel with their currents, but the inconvenience becomes very great when we are obliged to travel in the contrary direction. It has been found, therefore, more desirable to invent some mode of travelling on streams which are without currents, than on those which have them.

The English are, at the present day, sensible of this great truth, which was demonstrated to them by the arguments and labours of the celebrated Brindley, engineer to the Duke of Bridgewater. This skilful engineer, when examined before a committee of the House of Commons on the subject of a projected canal, vehemently maintained the utility of the scheme, although the proximity of a river appeared to render all artificial navigation superfluous. "For what purpose," asked a member of the committee, "do you suppose Providence created so many fine rivers in England?" "To feed canals," replied Brindley.

This bold, but most correct conception, will gradually overcome the prejudices which at first rejected it, and will, in the end, prevail amongst all enlightened and industrious nations. In those countries where commerce and the useful arts flourish, canals will, sooner or later, be constructed along the courses of irregular and rapid streams. This system will finally be adopted in France. A canal has already been commenced parallel to the Loire, and it is to be hoped that similar works will be undertaken at the side of the Rhone, the Durance, the Garonne, *&c.* But above all it is important that a canal should be dug along the course of the Seine, for the passage of large boats from Havre and Rouen to Paris. No expense should be spared in such an enterprise, which would confer at once on three cities new sources of wealth and prosperity. Vessels of considerable size might, by avoiding the windings and length of the river, arrive in a short time at the bridge of Jena, where a large port might be opened near the Champ-de-Mars. This single undertaking would, perhaps, suffice to change the commercial and maritime destinies of France. The attention of every friend of our national power should be directed to it, and we shall not be afraid to present on every occasion the views which may have already been taken of it by others. There are many useful works which will never be attempted unless at the end of every demonstration we persist in repeating—*therefore they must be constructed.* This is the way that the public mind is moved; it is thus that we obtain our object, as in former times it was attained by that persevering senator who ended all his speeches against the state of Carthage with these words—*therefore Carthage must be destroyed.*

But to return to the consideration of those works which promote the commercial prosperity of a nation. A still bolder idea than that of substituting parallel canals for natural currents, was the quitting the natural current entirely, and the forming new lines of navigation to pass from one valley to another, by passing the hills and mountains which intervened. The French, as has already been observed, were the first to offer an example of this grand idea to modern nations, in the canal of Briare.

The English were very late in entering into the career, the progress of which we have detailed*. The grandeur and number of their undertakings have, however, placed them at the head of all the nations, who have been most distinguished for this kind of reputation. What increases our admiration for the new system of English hydraulic communications, is its establishment in a country traversed by a high chain of mountains, and by numerous obstacles *(contreforts,)* which stretch themselves out to a great distance by hills more or less elevated; in a country too where greater difficulties were to be surmounted than in Lombardy, the Pays-

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* The first instance of a lateral navigable canal in Great Britain is that of the river Sankey which empties itself into the Mersey. This canal was commenced in 1755 and finished in 1760. The undertaking of the Duke of Bridgewater, which was the first canal that crossed valleys and the natural streams, is to be dated from this last period.

Bas, and Holland, the only states which can be compared with England for the number of their canals. The great chain, we allude to, is crossed by twenty-one canals, for the purpose of uniting the opposite courses of rivers discharging themselves into the German Ocean, the Atlantic, and the Irish Channel.

To make the points of junction beneath the high ridges which it was necessary to pass, and to remain in those regions where the proper quantity of water might be obtained, it was necessary to sink forty-eight subterraneous passages, the total extent of which is estimated to be nearly forty-five miles. This single fact affords some notion of the immense sacrifices which the English have made, in order to supply their inland commerce with all the hydraulic facilities necessary to advance it to the highest point of prosperity.

The length of Great Britain from north to south, being in proportion to its breadth very considerable, we perceive the great advantage derivable from an artificial navigation which should, at certain distances, connect the coast towards Europe with that which faces Ireland and North America. By this means the long and dangerous circuit of the island is avoided.

The canals running from east to west are the most important in Great Britain.

There are four great commercial ports in England. On the eastern coast London on the Thames, and Hull on the Humber. On the west, Liverpool on the Mersey, and Bristol on the Severn. These four rivers, and the territory which separates them, do not comprise half the superficies of Great Britain, but they comprise the greatest and most important part of the inland navigation of England. Within this district are the most populous and industrious towns, the most beautiful country and the richest counties. Some notion of it may be formed from the following table:—

TERRITORY.		TOTAL.	CANALISED.	NOT CANALISED
Superficies	England	58,185	30,926	27,259
	France	206,757	37,644	169,113
Population	England	12,218,500	8,662,200	3,556,300
	France	30,407,907	7,040,600	23,367,307
Population per square mile	England	210	280	130
	France	147	187	138
Length of the Canalised part per square mile	England		5,274	
	France		1,232	

To how many important reflections does not this brief table give rise! In England more than half the country is intersected by canals; in France not a fifth part. In that portion which is *canalised,* the quantity of the canals is a fourth less in France than in England, so that, in comparing the two countries together, we have not, in proportion to the extent of the respective kingdoms, the twentieth part of the canals possessed by our rival.

In England, with a sky less clear, a climate less genial, and a soil less fertile, the land supports on an average two hundred and ten inhabitants per square mile, and France, in the same extent of territory, supports only one hundred and forty-seven! In that part of England which is so well *canalised*, the number of inhabitants rises to two hundred and eighty the square mile, and in France it is only one hundred and eighty-seven. Nevertheless in England agriculture is distressed, because the superabundance of production has reduced prices too low. What an immense field have we to traverse, before we can arrive to that high degree of population and of productive industry, which render England so rich and powerful! One of the first and surest means of attaining this object of our efforts and our wishes, will be the improving, as much as possible, the general system of our internal navigation both natural and artificial.

Before we describe the principal directions of artificial navigation, we must say something of their relations to each other in reference to the comparative size of the boats which navigate them.

Grand and Small Navigation.

There are two kinds of canal in England, called *large* or *small section*, according as their breadth, and the size of their locks permit the passage of large or small boats; and these give rise to the corresponding systems of grand or small navigation.

All the canals of the large or small section have not exactly a determined relative size of locks, but they rarely exceed, in their difference of dimensions, the following proportions :—

Canals.		*Feet.*
Large	Sections: length of the locks	75.6.
Small		75.6.
	Width of the lock-gates	15.1.
		8.6.

From these data it is clear that in the two systems the boats may be of the same length, and even that the one lock will contain at the same time two smaller boats lashed together. The proportions of the grand and small navigation in England, are such that the channels suited to the first will likewise suit the second without any great inconvenience. The English, however, have never thought of arranging the two systems into one uniform and perfect whole. The very nature of English institutions is in opposition to such a harmony, The companies who construct any canal have the free choice of their own dimensions. There was nothing to restrain the first companies who were incorporated, and even in circumstances exactly similar, some have preferred the larger and others the smaller section. In some cases the same company has thought proper to construct one part of a canal according to the first, and another part according to the second system. When, however, the principal lines of the navigation are established, all the secondary canals branching from it ought to keep a correspondent proportion in their dimensions. The statement we are about to make, respecting the in land navigation in the heart of England, will clearly shew the mutual relation and dependence of these two kinds of canals.

Adopting the order of time, we shall begin with those canals of which Manchester is the centre; proceed to those which branch out from Liverpool, and then to those which diverge towards London, Bristol, Hull, and Birmingham.

CHAPTER II.

Hydraulic Communications with Manchester.

With the exception of London, Manchester is inferior to no other city in England in wealth, industry, and especially in population, which, in the space of sixty-three years, has made the following most astonishing progress:—

Years	1758	1781	1811	1821
Inhabitants	27,000	50,000	98,000	108,016

But these 108,016 inhabitants belong to the old town of Manchester only. If we add to it the villages which are comprehended at present in the increase of this town, we shall find a population of 149,756 persons. The town of Manchester contained 186,942 inhabitants at the last census in 1821.

This town, so celebrated for its industry, deserves equal celebrity for its love of science. The inhabitants, from their voluntary subscriptions alone, have established several considerable schools, reading-rooms on a grand scale, and extensive libraries. Three academies have been instituted here, which are highly distinguished for their labours: The Agricultural Society, founded in 1767;

the Philological Society, founded in 1803; the Literary and Philosophical Society, founded in 1781. The labours of Henry, Dalton, and others, have raised this last to an eminent rank, and affords a fine example to our large manufacturing towns like Lyons, Rouen, Nantes, *&c.* May it have the effect of exciting their emulation, and increasing their efforts to raise themselves in the cultivation of the sciences and the theory of the useful arts—studies which are indispensable to the perfect developement and practice of those arts.

These accumulated means of instruction, powerfully assist the manufacturing spirit of Manchester. This town is the chief workshop and the centre of the district, where are carried on the manufactures of those beautiful cotton fabrics, so diversified in their forms and uses, which constitute at present the richest branch of the export trade of England. It is from Manchester that the orders are issued to the whole of the surrounding district; and it is to Manchester that the spun and wove productions of that district are regularly brought, and form those immense assortments which are afterwards distributed to every quarter of the world. It now remains for us to state, how far inland navigation has facilitated these vast commercial transactions.

Manchester is situated at the confluence of the Irk, the Medlock, and the Irwell, which, having been rendered navigable to the Mersey, allows the passage of vessels of fifty tons. A single company, whose powers have been specifically regulated by the act of 32, Geo. III, has the management of the navigation of the Irwell and the Medlock, from Manchester to Runcorn. The ascent throughout this distance is seventy feet, which is overcome by means of weirs and locks. From Runcorn to Liverpool, the Mersey is navigable for vessels of considerable burden.

In the year 1758, the price of carriage from Manchester to Liverpool by this route, was twelve shillings per ton. As soon, however, as the canal, which we are about to describe, was finished, the price was reduced to six shillings, an important fact to shew how much artificial navigation is preferable to the navigation of natural streams*.

The Duke of Bridgewater's Canal.

The Duke of Bridgewater had not only the honour of being the first to afford a specimen to his country of the daring enterprise which the construction of canals required, but during the whole of his glorious and useful career, he exhibited the perseverance which gives a still higher grandeur to grand conceptions, by imparting to them in the course of years and by unceasing efforts, all the utility and extent which can be derived from time and human exertions. He gradually extended his canal in every direction where he thought it would be of service to industry and agriculture. It became the basis of a new system of hydraulic communication between the principal trading and manufacturing towns of England, both inland and maritime. He received the proper reward for his exertions and his sacrifices. Before his labours were completely successful, he expended nearly 300,000*l.*; but at the present day, the annual produce of that capital exceeds 60,000*l.*, or more than twenty per cent.! This immense revenue is so much the more to be admired, as it springs out of the same source of wealth, which has been laid open by the creative genius of a single individual, to the rest of his fellow citizens*. The Duke of Bridgewater derived from his great undertakings and extensive sacrifices, not merely this considerable return, but he gained a rarer, and for a generous character, a still more desirable distinction—that of seeing his name consecrated amongst those of the benefactors of a country, which it was his good fortune to serve, by giving it new means of wealth, prosperity, and power.

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* It is scarcely necessary to allude to the price of land-carriage, amounting to 40*s*. per ton, it was wholly incapable of competing even with the least advantageous modes of navigation.

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* At the commencement, the Duke of Bridgewater received a duty of 2*s.* 6*d.* per ton on all merchandise conveyed on his canal. Although it was afterwards tripled in extent of navigable line, yet he never asked for any increase of the duty, so great was the increase of the navigation.

We cannot but admire this mode of employing a splendid fortune and the influence of a high title, in the promotion and perfections of works, which half-barbarous nations, or those who are retrograding to the absurdities of barbarism, can alone regard as less glorious than the arts of destruction, or less honourable than the art of consuming without creating. We would propose this example to our own great proprietors and capitalists, whether titled or not, whether proud or not of their estates, their wealth or their dignities. We would shew them how their noble efforts would be crowned with a new splendour in the estimation of an age distinguished by its intelligence. The eyes of a nation advanced in civilization, can never be entirely fascinated by the childish spectacle of useless luxury. The rich cannot escape from the comparison with merit, by crushing it beneath their wealth. It is still, perhaps, flattering to the idle vanity of a Crœsus, to display in his palaces an Asiatic pomp, and to crowd the highways with his horses, his hounds, and his equipages. But all this ostentatious display inspires only hatred and contempt, unless its offensive qualities are redeemed by some ornament of honour and virtue, or by some services rendered to society. Luxury passes away with the perishable objects of which it was composed, and of its idle extravagance there remains too often only humiliating recollections. On the other hand, riches, when employed in the question of monuments of public utility become imperishable. Succeeding generations repair and preserve with a religious respect, the works of those who have been friendly to their fellow men; for nations always revere those labours which have been directed to their own well-being; they cherish a deep and generous love for the families which have bequeathed these durable legacies; and their mouths and hearts are ever ready to give their suffrage and support to the worthy descendants of their ancient benefactors.

Such is the legitimate and lasting recompense which attaches to the labours of the Duke of Bridgewater. To arrive at the success which crowned all his undertakings, he was fortunate enough to discover in a humble station, an artist whom nature had endowed—which she rarely does—with a fertile imagination and a correct judgment. James Brindley was his own teacher, and formed himself by the strength of his own genius: like Rennie and Telford, he began as a simple artisan; and like them, he became at last a distinguished engineer*.

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* Brindley was at first a mill-wright. He constructed machines of different kinds with great success, and improved the form and application of the steam-engine at the same time rendering it less expensive. To him England is indebted for the plans and execution of the Grand Trunk, and the Oxford and

The Duke of Bridgewater originally intended to establish a communication of no greater extent than about seven miles from his coal-mines, near Worsley to Manchester, a project which was sanctioned by the 32d Geo. II. The excavation was begun at the pits, and when it had reached the road which runs from Manchester to Warrington, the Duke obtained, by a new Act of Parliament, permission to change its direction, and crossing the Irwell by an aqueduct bridge, to continue the line of navigation along the southern bank of the Irwell.

In order to judge how far this first canal promoted the trade of Manchester, we will merely remark, that it suddenly lowered by one half the price of coal; and has ever since kept that price very low, notwithstanding the enormous consumption of the numerous steam-engines, which at this moment impart the moving power to the manufacturers of that town.

At Worsley-mill, where the canal leaves its subterraneous passages, a reservoir was at first constructed sufficiently large to contain at once the water for feeding the canal, and the boats necessary for the transport of the coal. Before reaching this

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Coventry canals. He also gave the plans for the canals of Leeds and Liverpool, Huddersfield, Chester, Forth and Clyde, and the Severn Grand Trunk, *&c.* He was born in 1716, and died in 1772.

basin the canal penetrates by a subterraneous gallery*, the mountain which contains the coal-mines. It is divided into two branches, which are lengthened as fast as the pits are excavated.

After quitting the subterraneous gallery and the reservoir, the canal passes over several roads on arches more or less elevated, according as the valeys which it crosses, are more or less deep. In those places where the level of the road is nearly equal to that of the canal, the road has been dug away so much, that the highest carriages may pass beneath the canal without any difficulty.

One of the greatest obstacles to overcome was, that of traversing the Irwell, between the waters of which and those of the canal, there was a difference in the level of forty feet. The aqueduct bridge, by which it was finally affected, begins at the distance of three miles and a half from the reservoir. It is six hundred and ten feet in length and thirty-six feet in width. It is built of large hewn stones, bound together by iron cramps soldered with lead. This beautiful bridge was completed in ten months. It rests on three principal arches. The vessels on the Irwell passes in full sail under the middle arch, which is sixty-two feet in breadth.

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* The opening of this gallery is six feet by five. Within, it is nine feet ten inches broad, so that two barges may pass each other. In some places the canal is dug through the solid rock, which serves for its lining; in other places it is lined with brick. At occasional distances, it is lighted by holes cut vertically through the roof, some of which are one hundred and ten feet in height. The subterraneous part of the canal is on two different levels, joined by an inclined plane, which we shall describe in treating of modes of conveyance.

At each extremity of the aqueduct bridge, a waste trunk regulates the height of the waters, which are thus prevented from overflowing the adjacent lands. In the same way, at each end of the bridge, and at other places where there is any reason to fear the bursting of the banks, *safety-gates* have been erected. They are in pairs so as to check the water in contrary ways. They turn on a horizontal axis, and are kept in a horizontal position sloping towards each other. In the ordinary state of the navigation, they are under water, and the barges pass freely over them. Whenever any part of the bank gives way, the waters from both sides rush towards the opening, and then the nearest *safety-gate* is raised so as to check the current in each direction.

It is apparent, therefore, that the only loss of water which can take place in case of any bursting of the bank, is that which is between the two gates, and thus the inundations cannot be either great or dangerous. The effect of these precautions is always in proportion to the extent of the canal on the same level. That of the Duke of Bridgewater being more than sixty miles in length, without any ascent or descent, this kind of precaution was so much the more necessary. When it is wished to let off the waters of the canal from the part which is above the aqueduct-bridge, the safety-gates at each extremity are closed, and a plug being taken from the bottom, the waters discharge themselves through a tunnel in the Irwell.

In order to make these safety-gates as small as possible, the canal is contracted by means of masonry, as is usual at the entrance of a lock, so as to leave only room enough for the passage of a barge. This masonry is somewhat concave on the side towards the water, and there is let into it by means of a groove, a frame generally of cast-iron, against which the gate closes, and exactly fits. On the other side of the masonry there is a similar gate, to act as an opposing power to the sudden motion of the water.

On both sides of the aqueduct-bridge, the canal runs over very low meadows, and in consequence of the looseness of the soil, the works have been so much the more considerable and difficult. It was necessary to drive down a range of piles on each side of the space intended for the canal, of about thirty-six feet in length, and bound together, by cross pieces. Several thousand oak piles were inserted at the bottom of this enclosure, and the middle was filled up with clay and soil taken from the trenches on the sides.

Mr. Phillipps, the author of a general history of inland navigation, in giving these details, explains the ingenious manner in which this causeway was executed. Two barges were joined together, at an interval of about two feet. They carried a third barge, capable of holding about eighteen tons of soil; the bottom of this last was made of valves, all of which opened by drawing out a single bolt. The two barges, with their burden, were then towed along a temporary canal, which ran parallel with the causeway. Above the embankment, however, was erected a kind of moveable platform, on a horizontal scaffolding. The third barge was hoisted up to this platform by means of an axle-tree, and was then moved, together with the platform, to the necessary spot, when the bolt of the valves was withdrawn, and the earth discharged. The barge was then lowered down upon the two others, and a new load was brought and discharged in the same way.

But to return to the description of the general line. Where the canal begins, at Wortley, there are two arms, which branch off; one of them serves to transport the earth, dug out of the coal-mines, as far as the vast marshes of Chatmoss, for the purpose of filling them up and rendering them arable. The other extends to the town of Leigh, which is famous for its fustian manufactories. In 1819 it was resolved to make a new cut from Leigh to Wigan, on the grand line of canals, which communicates on the north with Liverpool and Hull. This scheme, when executed, will serve to increase the wealth of Manchester.

Another branch, more extensive and more important, is that which leads to the Mersey along the south bank of the river and that of the Irwell, from Longford to Runcorn.

The part of this canal which is not subterraneous, may serve for the grand navigation. The branch, reaching from Manchester to the Mersey, is 50 feet broad, and 5 feet deep. The parts which are embanked are only half so broad, with a towing-path on each side of 9 $\frac{10}{12}$ feet breadth. At Worsley the tunnel is from 9 $\frac{10}{12}$, to 10 feet $\frac{2}{12}$ broad, so that boats 4 feet $\frac{7}{12}$ of width may pass each other with ease.

Including the 10 miles of underground navigation, in the mines at Worsley, the Bridgewater canal is 55 miles long on the same level. This level is also the same with the first 18 miles of the Grand-Trunk with which it communicates. Thus the inland navigation in the environs of Manchester presents a continued line of 70 miles, without either ascent or descent. Such a beautiful level could be effected only through the most daring and expensive labours, by long and deep cuts, by immense embankments, and great aqueducts. The energy of the Duke of Bridgewater, and the genius of Brindley, were able to triumph over all these obstacles,

All the canals which converge on Manchester, as well as that of the Grand-Trunk, discharge their waters into the Bridgewater canal, and always secure it a regular and copious supply. Independently of these supplies, and of those which issue from the mines at Worsley, the river Medlock furnishes the canal, even in Manchester, with a considerable quantity of water. This supply is effected by a kind of reservoir, the flood-gates of which, as well as the grooves in which they play, are made of cast-iron. In the middle of the reservoir, formed by these gates, (*vannage,*) there is a circular discharger, about sixteen feet in diameter. Into this the superfluous water falls, and is conducted by a subterraneous pipe into the river Irwell. A reservoir of this kind was first constructed at Colnbrook to feed this canal.

Near the reservoir of the mid-lock, there is a quay for the unloading and the retail sale of the coals brought hither by canal. It was wished to avoid the land-carriage of this combustible to the high spot called Castle Hill. For this purpose, Brindley caused a tunnel to be bored under the hill, with a well at the end of it; by this well, the boats are raised into an upper basin, by means of a large hydraulic wheel.

The Duke of Bridgewater's canal, continued on a level through its whole course, is at Runcorn, where it joins the Mersey, about ninety-five feet above that river. From this elevation we descend on a space of 660 yards by ten locks*, each measuring eighty feet in length, by fifteen feet in width.

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* The masonry of the locks, and the timber-work of the gates, are of an extremely simple construction. The gates are plane. The horizontal beams which form the frame, are squared on thin vertical faces only; their horizontal faces follow the grain of the wood. The upper beam, instead of being horizontal, rises on the land side and projects over the bank, breast high. It forms the arm of a large lever, against which they shove when they want to open or shut the canal. The structure of the gates is the same in all common canals.

Towards the summit of the hill on the declivity of which this descent takes place, a large reservoir supplies the necessary water to fill the locks, to enable the boats to descend from so considerable an elevation, without too much exhausting the waters of the canal. At the bottom of the hill itself, three rectangular basins, very long, and placed in stages by the side of each other, serve to receive the boats of the canal and the larger vessels which come from the Mersey.

There are two issues* of the canal at Runcorn. Downwards, the issue is by a single gate, situated at the western extremity of the dock nearest to the river. Upwards, it is by a basin, which serves also to careen the boats of the canal and the vessels of the Mersey; close by these are docks for building vessels. In the intervals between the three basins, there are very fine warehouses belonging to the canal; some of them are ten stories high.

Not far from this, is the pretty town of Runcorn, which owes all its opulence to the navigation of the canals and of the Mersey. The oldest houses are so clean and neat, that they look as if they were only built yesterday. Some are just completed, many others are building, and prove the constant prosperity of an active population. Runcorn, the chief town of an industrious parish, which, at the time of the last census, contained 37,192 inhabitants, is the place where several very opulent canals cross each other. There terminates the lateral canal of the Mersey and the Irwell, by which vessels avoid, for a great extent, the troublesome assent of the natural bed of those rivers, to go to Warrington and Manchester*.

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* Each of the entrance locks is broader than those we meet on the canal, in order that the vessels coming from the Mersey may pass more easily. The fall of the entrance lock is twelve feet; at the place where they are constructed, the tide rises sixteen feet.

The boats employed upon the canals, which terminate at Runcorn, are towed by horses; they are very long, narrow, flat, with vertical sides. The head and stern are cut like a wedge, with the faces arched. The boats used on the several canals in England are almost all of the form which we have just described.

If the Duke of Bridgewater's canal is remarkable for the beauty and originality of its works, it is no less so, in our opinion, for the spirit of order and economy which directed the execution of the labours. The materials were taken from the quarries, the mines, and the forests of the Duke's estate. Thus he had, as it were, only the manual labour to pay, and Brindley, the engineer, knew how to render that as little expensive as possible. In proportion as the digging of the canal proceeded, the part already rendered navigable served to convey the materials now necessary for the continuation of the enterprise. Every boat which brought the stones and timber was at the same time a workshop for the men employed to cut them into the form required; thus, all confusion on the spot where the works were carried on, all loss of time and of labour, were avoided. Let us hope that the companies established in France, for the execution of canals, will imitate this example of judicious economy; they will be rewarded for it by the same success, and their opulence will be the fruit of their wisdom. The picture of the operations executed by the Duke of Bridgewater, and of the advantages which he had derived from them, ably represented by Sir Richard Whiteworth in 1766, had the greatest influence on the calculating spirit of the English, to convince them of the superiority of artificial navigation over that of natural currents of water. A similar success obtained in my country, through the publication of my travels, would be the highest reward that my ambition could obtain.

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* This canal, like that of the Duke of Bridgewater, has a depth of water of five feet; it serves for boats which, when loaded, draw four feet. It ends at Runcorn, in a long basin of twenty feet broad, and which contains a depth of ten feet.

The Lateral Canal of the Sankey.

It has its origin in the Mersey, a little above Runcorn; it passes by Newton, a manufacturing town, especially of goods of the same kind as ar manufactured at Manchester; it proceeds toward the founderies of the Anglesea Copper Mine Company, and near the glass manufactory of Lancaster; it terminates at the coal-mines of St. Helen, in the neighbourhood of Prescot. The productions of all the centres of industry are conveyed to Manchester and Liverpool by the canal of Sankey, by the Mersey, and the line of artificial navigation of the Duke of Bridgewater. The canal is twelve miles long, it descends seventy-eight feet by ten locks; the depth of the water is above five feet and a half.

A little below Runcorn, on the south bank of the Mersey, which spreads in this part into a large bay, the Weaver empties itself, which has been rendered navigable from the salt-works of Winsford, by lateral cuts, and difficult and expensive works. Let us return to Manchester, and take a view of the other lines of navigation which commence at that city.

North-West Direction Canal of Bolton and Bury.

It is opened in great section, like the Duke of Bridgewater's, with which it commmunicates by the Irwell, at Manchester. In the part of that city called Salford, there is first a basin, which serves as its port; then it is composed as follows:—four miles on level ground; then three miles of ascent, which are overcome by twelve locks; then four miles level as far as Bolton, with a branch of four miles to Bury.

Bolton and Bury are two very rich and industrious towns, which may be considered as manufacturing dependents of Manchester. Setting out from this last town, the canal which bears the name of the two former, passes into the valley of the Irwell, crosses that river above a place called Clifton Hall; then afterwards crosses the Roche, then divides into two branches, one of which goes to Bolton, and the other to Bury. In 1821, the two parishes of Bolton and Bury contained together 84,768 inhabitants; they were indebted for the rapid increase of their population chiefly to the new means of communication formed, within a few years, with the centre of the industry and commerce of this country.

North-East Direction Canal of Rochdale.

It joins in the town of Manchester itself with that of the Duke of Bridgewater by a tunnel; passes by Rochdale, and goes as far as the town of Halifax. It was begun in 1794, and finished in 1804. It is opened in great section, for boats of the breadth of fourteen feet.

The following are the principal measurements of its course:—

Setting out from Manchester,	length 15 miles;	ascent 432½
Summit Level . . .	length 5¼	
Thence to Halifax . .	length 11¼	descent 276.

Sutcliffe, author of the *Treatise on Canals and*

Reservoirs, makes some remarks on the canal of Rochdale, which claim our attention. When this canal was projected, it was taken for granted, that a reservoir, having sixty acres in superficies, and with a mean depth of water of fifteen feet, would afford a sufficient supply for the navigation. This was very far from the truth. It has been necessary to dig five other reservoirs, the mean depth of which is thirteen feet, and the surface 320 acres; they contain 155,477,000 cubic feet of water renewed twice a year. This is more than triple the quantity which had been calculated as necessary for the usual service of the navigation without any loss of fluid. Yet, besides these means of supply, it has been necessary to have recourse to mechanical processes. A steam-engine of a hundred-horse power, is placed at one of the extremities of the level summit, to raise the water out of a large reservoir, while itself receives that of two others, the total capacity of which is about 75,000,000 cubic feet. Notwithstanding all these precautions, the navigation is interrupted during a part of the summer, when the dry weather is of long duration. These observations show how important it is to study the nature of the ground, in order to be assured that the filtrations will not render illusory the most prudent calculations, made to estimate before-hand the supply of the canals.

The town of Rochdale, which gives its name to the canal, is so called from the valley watered by the Roche, a little river which falls into the Irwell. This town manufactures all sorts of stuffs; it has 47,109 inhabitants in its parish. It owes much of its recent prosperity to the canal, the course of which we have just pointed out.

This entirely modern prosperity is still more striking in the parish of Halifax, which, in the year 1811, contained only 73,415 inhabitants, and, ten years later, contained 90,815. Halifax itself, situated on the Calder, which empties itself into the river Air, whence you descend by the Ouse into the bay of the Humber, is a centre of manufactures for spinning, weaving, and dyeing wool and cotton. Its orders extend to all the surrounding country. Its productions placed on the line of navigation which joins Manchester, Liverpool, and Hull, can circulate through all the interior of England, or be conveyed direct, either to the coasts of the German Ocean, or to those of the Irish Sea.

Direction of the East.

The canal of Ashton and Oldham begins near Manchester, setting out from the canal of Rochdale; it is opened in small section, is about eleven miles in length, and rises 160 feet to the town of Ashton; a branch towards the north leads to Oldham. The parishes of Oldham and Ashton, both enriched by the spinning and weaving of cotton, contain, the latter, 25,967 inhabitants; the former, 50,000. The canal of Ashton and Oldham has other ramifications leading to the great manufacturing establishments in the neighbourhood. The principal branch, in a south direction, is six miles long; it leads to Stockport, in the county of Chester. Stockport not only enjoys the advantage of the canal which gives it a communication with Manchester, but it is built on the banks of the Mersey, at the very place where the navigation of that now terminates, which affords it the most prompt and cheap conveyance for its export produce to Liverpool.

The Canal of Huddersfield

Is the prolongation of that of Ashton. From that town it proceeds to the north-east, and ends at Huddersfield, on the banks of the Calder. Consequently, the two canals of which we speak, unite two navigable rivers, the Calder and the Mersey, which flow into opposite seas. It is the canal of Huddersfield which traverses the great chain of mountains, to form a junction between these two rivers, flowing in opposite directions. This passage is effected by means of a tunnel, almost the whole of which has been cut in the rock. It is 5280 yards in length, and the longest of all those which have been made in Great Britain. From Ashton to the summit level, the canal of Huddersfield is eight miles and a half, and ascends 334 feet by thirty-one locks. The length of the summit level is three miles and three-quarters, thence to Huddersfield the canal is seven miles and a quarter, and descends 436 feet; it can only be supplied by reservoirs; the principal is above sixty-nine feet deep.

The Canal of Peake Forest

Has its origin at the extremity of the canal of Ashton, and its course is towards the south-east. It is seventeen miles in length; and is prolonged by an iron rail-way to the quarries of lime-stone of Loads-Knowl. It has two branches, one canalized, the other formed by a rail-way, one mile and a half in length. This canal, opened in small section, like that of Huddersfield, passes through a country which is very uneven; this has rendered great works necessary.

For instance, an aqueduct-bridge of three arches of sixty feet span, and ninety-eight feet and a half elevation; an inclined plane which, on a length of 514 yards, ascends 203½ feet, making an ascent of thirteen in a hundred.

The short Canal of Ramsden,

(The name of its proprietor), goes from the river Calder, to the canal of Huddersfield.

It was from 1792 to 1794 that the canals undertaken in the directions of the north-west, north-east, and south-east of Manchester were begun; almost all of them were completed with rapidity.

If the reader has been able to induce himself to follow the dry and tiresome itinerary of these hydraulic communications, opened on all points of the horizon of which Manchester is the centre, he will conceive what advantages that commercial town must have derived from so fine an assemblage of works. Let us take at once the four great canals of Briare, de Loing, Orleans, and Saint Quentin, the only ones which are yet navigable round Paris, in an extent of forty-two leagues; let us bend and compress them in a circle thirty-six times less spacious, and we shall have a precise idea of the canals which branch around Manchester, about the distance of seven leagues! Let us add to these artificial communications, the navigation of the Irwell and the Mersey; then seven great turnpike-roads which lead from Manchester; lastly, all the iron rail-roads from the divers canals to the mines and these manufactories, which stand enclosed, we shall then have an idea of the means of communication which the art of public works has given to this focus of industry, and we shall cease to be surprised, that from 1758 to 1821, that is since the iron rail-roads and the canals has been made, the population of Manchester has increased from 27,000 to 150,000 souls.

CHAPTER III.

The Hydraulic Communications of Liverpool.

In the succeeding volume, we shall describe the maritime and commercial establishments of Liverpool; but here we have to consider that town only as a centre of inland navigation. Independently of its communications with Manchester, Liverpool has three grand débouchés by water: to the *south*, by the canal of Ellesmere, thence by the Severn to Bristol; to the *east*, by the Trent and Mersey canal to Hull; to the *north*, first, by the Leeds and Liverpool canal, whence you may go to Hull; secondly by the Lancaster canal, which goes to the County of Westmoreland.

Communications on the South.

Setting out from Liverpool, if we ascend the vast basin of the Mersey, we find in the north bank of that river, a little bay, now called Port Ellesmere; it is the entrance of a line of canals, which passes first by Chester, then by Nantwich, and then by Ellesmere, the central place that gives its name to the whole line, which has now become the property of a single company.

The branch of the canal included between Port Ellesmere and Chester, began in 1793, and completed in 1796, is on one level in its whole length, which is nine miles; it is fit for the navigation of large craft. It issues by three locks into the Mersey, and by three other into the Dee, at the gates of Chester*. Chester, the capital of the county, is situated on the river Dee, at a small distance from the sea. When we treat of the sea-ports, we shall speak more at length of this city, which is remarkable on account of its monuments, its manufactures, and commerce.

When we quit the branch of the canal which begins at Port Ellesmere, we enter immediately *the canal of Chester*, which joins the Dee under the walls of that town, by a lock. This last canal, undertaken so far back as 1770, was at first intended only to convey the produce of the salt-works of Middlewick, Winsford, and Nantwich†, at which town it terminates; it is sixteen miles and three-quarters in length. To derive the greatest possible advantage from it, it ought to have been brought as far as the Grand Trunk canal which passes by Middlewich; this was in fact the original intention. By this means, all the counties crossed by the Chester and Ellesmere canals, would have had a direct communication with the great ports of London and Hull, as well as with the richest provinces of England. But while it was permitted to continue the Chester canal to the bank of the Grand Trunk, it was forbidden to make it open into the latter. Checked by such an obstacle, the Chester Canal Company did not execute that part of its line of navigation, which was to go from Nantwich to the salt-works of Winsford and Middlewich. We mention this fact, though it is uncommon of its kind; it shews, that even among nations where the legislator is the most enlightened, he may be surprised into granting restrictions, contrary to the general spirit of his acts, and injurious to the public good.

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* This canal, of grand section, is for boats fourteen feet broad and seventy feet long. The depth of water in the canal is four feet and a half.

† From Chester to Nantwich, the canal rises 170 feet. It is on great section, as well as its prolongation to Port Ellesmere. There are four towns called the *Wiches*, where the salt-works are situated. Nantwich is the oldest, and at present the least considerable. The three others, Middlewich, Northwich, and Winsford are much more important. The two latter are, like Nantwich, upon the river Weaver; Middlewich is on the banks of the Grand Trunk Canal, which crosses the Weaver at Northwich.

The restriction of which we speak, and the decline of the salt-works at Nantwich, had caused the shares in the canal from Chester to that town to fall very low. Happily the idea occurred of prolonging it by Ellesmere*, to form a great system of internal navigation. It is now much frequented, and consequently very productive.

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* Ellesmere, an old Saxon town, is on the banks of a large lake belonging to the Duke of Bridgewater. This lake was formerly called *Alsmere*, or *Mare Principale*. The population of Ellesmere is 5,639; this town is only six miles from Chirk.

From Nantwich to Llanymynech, in Wales, a first line is directed from north-east to south-east. From Shrewsbury, on the Severn, to Llandesilio, on the Dee, a second line extends, which crosses the first at right angles. These two lines complete the canal of Ellesmere, and form a cross, the four branches of which we shall designate by the place at which each of them terminates.

The following is their extent:—

Branches of Nantwich . . .	35 miles
Llanymynech . .	11
Shrewsbury . .	16
Llandesilio . . .	16¾
TOTAL	78¾

To obtain a knowledge of their course, we will begin with the first branch. Let us embark at Nantwich, in barges seventy feet in length, seven feet broad; they will find through the whole extent of the lines which we are going to follow, four feet and a half depth of water. In the twelve first miles, we ascend 128 feet by nineteen locks. We then see on our left hand, Whitchurch, a market-town, towards which there is a navigable branch which extends between four or five miles further to some quarries and mines, the produce of which is brought by this way to the principal line. Following our course, we see other branches leading from quarries and lime-kilns to the principal line. We reach Ellesmere, where the company has stationed its office and the central agency of its operations; three miles and a half beyond, near the locks of Frankton, we cross the grand line of navigation, perpendicular to that which we follow; we descend nineteen feet by three locks, then re-ascend to Llanymynech, on the banks of a river which falls into the Severn. Four rail-ways are the ramifications of the second branch which we have just passed over.

The Canal of Montgomery is only the continuation of this branch of the canal of Ellesmere from Llanymynech. When we visit it, we remark the great aqueduct bridge of stone on the river Vyrnwy; then a considerable branch which encompasses the valley of Gnisfield; the principal branch descends twenty-nine feet and a half by four locks. Thence the canal ascends again seventy-one feet by nine locks; its total length is sixteen miles. After having traversed the valley of Gnisfield, it goes by the side of the Severn, passes by Welch, where a great quantity of woollen goods is manufactured; it is the commercial centre of the fertile valley of Montgomery, which is watered and vivified by the Severn. In a course of above 217 miles, this fine river is navigable as far as Welch Pool, a town containing 3,440 inhabitants. A recent enterprise continues the canal of Montgomery as far as the town of Newton. This new line rises forty-seven feet and a half in a length of nine miles. Agricultural produce, timber, minerals, are exported on this canal, by which every thing necessary for the Welch is imported in return.

Let us now place ourselves at the lowest point of the second line of the Ellesmere canal, that is to say at Shrewsbury on the Severn; ten miles and a half of canal are still wanting to complete this line. Following it, we ascend first 134 feet, on an extent of one mile and three-quarters, then we proceed fourteen miles and a quarter on one level; we ascend thirty feet by the four locks of Frankton, which are near the crossing of the two great lines of the canal; three miles farther, we again ascend thirteen feet by two locks; all the rest of the canal is on a level. This last part is fourteen miles and a quarter in length; it is the most interesting of all on account of its beautiful works: in this short space, it presents the stone aqueduct erected at Chirk to cross the Ceriog, then two tunnels, afterwards an aqueduct of iron to cross the Dee at Pont-y-Cyssyltan. Beyond this aqueduct, the canal is parallel to the river, and hollowed in the rock, for a great portion of its length, as far as Llandesilio, above Llangollen.

Between Pont-y-Cyssyltan and Llandesilio, a great iron rail-road was to be extended by a new ramification of the canal, in ascending, on one hand, to the county of Flint, and descending, on the other, to the left bank of the Dee, as far as Chester. By this means, the communications from that city with the upper part of the counties of Flint and Denbigh would be much shortened. This project will doubtless be one day executed.

At Llandesilio, the Dee has a dam of stone and sluices to feed the canal, which supply is obtained in great abundance, because the Dee, above Llandesilio, receives the waters of very spacious and deep valleys, and those of Bala Lake, the length of which is above three miles and a half. A regulating dam economises the water of the lake, so that they may suffice for the supply of the canal, even during the longest droughts. In short, this supply is the more advantageous, that it furnishes, from the most elevated points, the necessary water to three branches of the Ellesmere canal; those of the north, east, and south.

So vast a combination of inland navigation, by procuring outlets for the territorial produce of the counties of Flint, Denbigh, Montgomery, Shropshire, and Cheshire, is an immense advantage to the numerous valleys, whose agricultural produce and manufactures it conveys. To these must be added the produce of the mines of salt, iron, and zinc, and of the quarries of slate, lime, marle, *&c.*, with which the counties just named abound. We shall then have an idea of the riches which, thanks to the communications opened by the Ellesmere canal, are conveyed, according to the speculations of the merchants; first, by the Mersey, to Liverpool, Ireland, Manchester, and the north of England. Second, by the Severn, to Bristol and to the south. Third, and last, by various canals to London and all the eastern part of Great Britain.

The Ellesmere canal is perhaps the only example that can be produced in the three kingdoms, of a system of canals, combined in this manner for the special wants of the works in the mines, and of agriculture, while the supply of the manufactories and towns is an object of secondary importance; hence, the principal landholders of the valleys with which the canal of Ellesmere now opens a communication, were the persons who, as early as 1792, formed the company to which this noble enterprise owes its origin. This is an example which should especially interest the provinces in the centre of France, the landholders in which may acquire an entirely new source of territorial riches, by combining a similar system of internal communication for the disposal of their agricultural produce.

The Ellesmere canal, so remarkable for its object and extent, is no less so for the beauty of several works of art, the merit of which we were the first to make known to the engineers of the Continent*. It must claim the attention of scientific men on account of the two aqueduct-bridges which it has been necessary to erect, that of Chirk, built of stone, and especially that of Pont-y-Cyssyltan, which is of iron.—*See plate.*

The canal bridge of Chirk is composed of ten arches; it is 500 feet in length, between the butments, which extend fifty feet on each side; this makes its total length, six hundred feet: its elevation above the Dee at high water is equal to sixty-five feet and a half. The breadth of the canal on the aqueduct is twelve feet, not including a towing-path, as may be seen in the plate, in which we have represented this aqueduct.

Setting out from Chirk, we pass under the first tunnel, 500 yards in length; the canal runs then in the open air, by means of a deep cut, one mile in length. The second tunnel is 600 feet in length, and opens into the valley of Dee, which the canal crosses at Pont-y-Cyssyltan.

In this place is a bar, which is drawn across the canal when it is necessary to stop the navigation. When it is free, this bar is received in a chamber, or deep recess, of equal dimensions, cut in the bank of the canal; a capstan is used to draw it in and out of its recess: this bar, which is of wood, is made to run and to fit in a groove at the bottom of the canal, and on the opposite bank.

In 1795, Mr. Telford, who was intrusted with the direction of the Ellesmere canal, conceived the idea of substituting iron for the coating of clay with which the English line their aqueduct bridges. He first

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[*] It is in the memoirs on the marine bridges, and higher roads of France and England, that they are first mentioned.

tried this at Chirk, as a prelude to the beautiful construction of Pont-y-Cyssyltan; above the arches of the aqueduct of Chirk he built side walls with brick, in the usual manner, but with stone coating. Between these walls he laid down large plates of cast-iron, for the bottom of the canal, carefully clamped, then fastened with iron pins, screwed and caulked in the joints; these plates serve at the same time as continued holdfasts, in order to prevent the side walls from being thrown outwards by the pressure of the fluid.

The works necessary for erecting the aqueduct of Pont-y-Cyssyltan were attended with much more difficulty; it was requisite to execute the canal at a height of 126½ feet above the surface of the river, at a place where access was had by a causeway 500 yards long, seventy-six feet and a half high, and forty-two feet broad at the top; it was found by calculation that it was more advisable to erect a canal bridge 1010 feet in length, than to carry this immense causeway any further. To execute this bold enterprise, Mr. Telford resolved to make still more use of iron than in the works at Chirk; he erected nineteen metal arches on eighteen piles of brick, to two butments of stone. This aqueduct alone cost fifty-four thousand pounds sterling.

The arches represent two segments of a circle, each formed by four ribs of cast-iron, which are open in order to be lighter; the open parts have the appearance of the stones composing a stone arch, while the bars, or solid parts, may be said to represent the arras of such stones.

To give to the structure a greater power of resistance against the pressure of the water, the sides of the canal are composed of strong plates of wrought iron, not cut straight, but so formed as if they were a continuation of the lines presented by the solid parts of the ribs of the bridge; and the plates which join the parts of one arch with those of another are wider at the bottom than at the top, which produces the same effect as that of buttresses supporting a wall. *(See plate.)*

The towing path is a little above the surface of the water, within the aqueduct; it is composed of pieces of timber lying transversely, and resting upon the heads of posts or muntins, which are equidistant. These posts are upon two rows; one is close to one of the sides of the aqueduct; the other under that edge of the towing-path nearest to the middle of the canal. Strong beams go from one post to the other, and are secured by braces placed diagonally between the opposite posts; thick planes, closely joined together, rest upon these beams, and finally a layer of gravel, well bound together, covers this wooden platform: the object of this gravel is not only intended to preserve the floor from the injury it would receive from the horses' shoes, but likewise to prevent the shaking which these animals would occasion in treading heavily over an elastic surface; this shaking would be sufficient to disjoin rapidly all the parts of this *bridge canal.* An iron railing, about three feet high, runs along the exterior hedge of the towing path, and serves the purpose of a parapet.

Such is the aqueduct of Pont-y-Cyssyltan, which for its lightness, simplicity, and elegance is a model of its kind.

Near this aqueduct, ascending the left bank of the Dee, there are several basins to receive the boats that come to take in their cargoes, which chiefly consist of iron and coal. Most of the piles of the aqueduct rest upon layers of coal.

The valley of Llangollen, in the midst of which this monument of art is erected, is very striking in its appearance. I have endeavoured to give an idea of it in the short narrative of my second journey, as follows:—"From Chester I went to Wales, to visit the works of the Ellesmere canal; the most important, in my opinion, was the aqueduct of Pont-y-Cyssyltan, thrown over the torrent-like river which flows through the valley of Llangollen. At the height of 127 feet, and for a length of 1000 feet, you see an aërial canal, the metallic envelope of which is supported by bold and light piles. Boats heavily laden, and the horses which tow them, securely pass over this road, hanging over an abyss, and carrying to Ellesmere the coal, the lime, and the iron furnished by the mines, the quarries, and the forges of the vale of Llangollen.

"After a long and fatiguing walk, I entered the valley on a fine autumnal evening, almost at the moment of sunset; never did a more magnificent scene burst upon my sight, in the midst of a vigorous vegetation, still retaining all its freshness; columns of smoke and flame; perpetual eruptions from the craters of industry; furnaces, forges, limekilns, and heaps of coal ignited to become, by the very operation of ignition, a perfect combustible; manufactories, country-houses, and villages, placed in the form of an amphitheatre, on the sides of the valley; below, a rapid torrent; above, the canal bridge, placed, as if by enchantment, on lofty and slender pillars of an elegant and simple construction; and this magnificent work, the fruit of the happy and bold efforts of one of my friends! Lost in the contemplation of these beauties of art and nature, which by the fading away of the declining light, changed their appearance every moment, I stood as it were in ecstasy, till the close of twilight obliged me to retire, and seek an asylum at some miles' distance. This is what I have seen, but which I cannot describe without depriving it of the charms of reality, and which nevertheless, in spite of time and distance, still makes my heart beat at the recollection of the emotions which this magnificent scene excited in me."—(*Memoires on the Marine Bridges and Highroads of France and England.*)

Canal of Shrewsbury.

Its utility will become much greater when the Ellesmere canal is finished; at present it serves to convey coals to Shrewsbury, a commercial and manufacturing town, with a population of 20,000 inhabitants, enriched by the traffic, both on the Severn and on the principal roads from Birmingham and London to Dublin.

Leaving Shrewsbury, to follow the line of the canal, we proceed towards the east end, pass, first a tunnel 970 yards in length; after going twelve miles, as far as Langdon, we traverse the Turne on an aqueduct bridge of iron*; it was the first that was built in England, and was executed by Mr. Telford, in 1795 and 1796. Those persons who always prophecy ill success to works of a new kind did not fail to affirm, that in winter the ice would warp the the walls of the canal; they pretended that the variations of the temperature causing the iron alternately to dilate and to contract would produce rupture, and soon render the metal aqueduct unserviceable. Experience has proved the contrary.

Setting out from this aqueduct, we ascend nearly eighty feet, by several locks, on an extent of four miles and a half. At this distance we are at the foot of an inclined plane, which also rises eighty feet, on a length of 610 feet; this inclined plane renders it necessary to employ very short boats; they carry only eight tons. We shall describe the manner of working them, when we treat of conveyances.

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* It is 186 feet long, and stands fifteen feet and two-thirds above the water in the Turne. The towing path is outside.—(*See the plate representing this aqueduct.*)

In order to avoid the loss of water which would arise from the passage of such short boats through long locks, each of them is divided into four parts by three inner gates, which turn like the safety-gates previously described on a horizontal axis, lining at the bottom of the lock. The water may be introduced in each of these compartments, and drawn out of it independently of the three others.

Towards its eastern extremity, the Shrewsbury canal divides into two branches: one ascends to the north as far as Newport; this branch, upon which there is an inclined plane, is the work and the property of the Marquess of Stafford; it is above six miles in length. The southern branch is very short, but it has been prolonged by the Shropshire canal, the essential object of which is the exportation of the produce of the quarries, mines, founderies, *&c.*, of iron, lime, and coal.

The Shropshire Canal is celebrated in the history of the art. It descends to the Severn, which it joins in two points, by means of a bifurcation; though only fifteen miles in length, it has, in that short space, three inclined planes—

	Feet long.	Feet high.
The first near the Shrewsbury Canal . .	961	120
The second situated near Windmill * . .	1800	126
The third at Hay, near the Severn . . .	1050	207

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* At the inclined plane at Windmill, six boats ascend and six

The first two are like that of the Duke of Bridgewater's canal, the third has a remarkable particularity; this is a counter plane, about thirty feet in length, by which it re-descends into the upper part of the canal. A steam-engine of six-horse power serves to make the boats ascend on this last plane, which for the rest does not differ from the others.

We have said that the Shropshire canal divides into two branches, which go to the Severn; the western branch joins that river near the celebrated foundery of Colebrooke dale, where the first iron bridge was cast. Before the adoption of inclined planes, this branch presented a very singular establishment. Two wells had been dug thirty-two feet in circumference, and one hundred and twenty-two feet in depth. On the loaded boats coming from the canal to the upper mouth of one of these wells, their cargo was put into iron chests, which were let down the well, and reached the bottom of a subterraneous vault, going from that point to the lower part of the canal, which issues into the Severn; the iron cases were raised and let down by means of a large wheel, with a curb placed between the two wells. It has been found much more advantageous to employ inclined planes, which saved the trouble of unloading and re-loading. The Shropshire canal,

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others descend in an hour; three men are sufficient to direct them. The burden of these boats is from five to eight tons; they differ only in the depth of the hold.

like all those which pass near the mines, is partly fed by the water exhausted from the mines, which is raised by means of the steam-engine; a similar machine serves also to pour into the bed of the canal the water of a reservoir placed on a lower level.

The Ketley Canal,

Which communicates to the rich founderies of that name, is only a branch of the Shropshire canal; it has the first inclined plane which was made in England*: the boats† which are to pass it are placed upon a carriage, the fore wheels of which differ in size with the hind ones, in order that its platform may be horizontal; these wheels are of cast-iron. When the carriage arrives at the top of the inclined plane, it enters into the lock, and its platform is then on a level with the bottom of the canal; when a loaded boat descends, its weight and impetus are sufficient to draw up another boat carrying two and two-thirds tons.

From the summit of the inclined plane, the little canal of Ketley leads to the mines of Oken Gates. In order to economise the little water that can be employed for this navigation, a reservoir on the side of the lock, which joins the inclined plane, receives half the water which must serve each time to fill the lock. When the water becomes too scarce, a steam-engine restores to the canal what has been expended at the passage of each boat.

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* This plane has a fall of seventy-three feet, and is 670 long; it has a double rail-road.

† They are twenty feet long, six feet one-third broad, and three-feet eight-inches deep; they carry eight tons.

South-East Direction.

The communications east of Liverpool, are carried on in the south side by joining the Mersey which flows towards the west with the Trent, which runs in the opposite direction, and falls into the basin of the Humber, on the banks of which the great port of Hull is situated. We have already described the navigation of the Mersey. From this river we enter part of the Duke of Bridgewater's canal, which we follow as far as Preston Brook, where the Trent and Mersey canal begins, which is called the Grand Trunk, because it is like the stem of the tree from which almost all the branches of the inland navigation of England spread out. It was at Liverpool that the idea of opening such a canal was first conceived (in 1755), but it was in a direction which was not adopted. The line of navigation that was preferred in the sequel was planned by Brindley; it was adopted in 1765 by an association, composed of the principal landowners, manufacturers, and merchants of Staffordshire, directed by Admiral Anson, and with the Marquess of Stafford for president.

Most of the associations of this kind formed in Great Britain, have in the same manner had for their promoters and advocates, some of the most distinguished members of an aristocracy, whose patronage extends to all the works of public utility. The noblemen, who thus take under their protection some new project, begin by employing agents in the country which is to reap the benefit of their active and powerful influence, to get it approved by the principal inhabitants, and to induce their own friends, opulent and numerous, to contribute to the expense of the proposed undertaking. Afterwards, in order to obtain the assent of the legislature, they employ in the two houses of parliament their interest, that of those members who are under their powerful patronage and influence, and often even that of all the political party to which they belong. Such, according to the wish which we have expressed in the introduction, is the useful patronage which we should like to see instituted by those families in our country, who have acquired some authority over the minds of others, by their rank, their titles, and their talents, and their high functions in the administration or in the legislature. In France, there are few private persons rich enough to make such sacrifices as the Duke of Bridgewater, and to execute at their expense great public works; yet many of them may assist and direct the associations to be formed, or which are already formed in their respective departments. It is one of the surest and most advantageous means of influence which can be offered to the higher class, which in our new state of society, endeavours to place its interest and its power on lasting foundations*. It must always have present to its memory, a great truth confirmed by experience; it is not by accumulating estates, treasures, *majorats*, and entails, but by acquiring rights to the esteem and gratitude of the people, that the British aristocracy causes its titles and privileges to be tolerated, I might almost say, loved. But let us return to the canal commenced under the patronage of the Marquis of Stafford.

Staffordshire, which this canal traverses and vivifies, is a province equally remarkable for its rich pasturage and fertile arable lands. Its soil contains mineral riches not less valuable; iron, coal, lime, alabaster, the clay fit for fine earthenware, china, *&c*. Such is the opulent country, which has become the centre of the inland navigation of England, since the opening of the Grand Trunk canal.

A great number of manufactories rapidly rose in the neighbourhood of this canal, while the old ones have acquired greater prosperity, notwithstanding the competition. Agriculture has also benefitted by these new communications and outlets. Every interest of this kind is so well understood in England by the land-owners, that those whose estates were situated in the line of the Grand Trunk canal, offered, for the most part, to give gratuitously as much of their land as would be required for the breadth of the canal; when, at the same moment, they advanced their money to meet the expenses of an undertaking from which they expected to derive so much advantage. Experience has justified the hopes which they had conceived, by success, which exceeded all that the most favourable calculations had held out. The income has increased to such a degree, that the dividends fixed at first at five pounds sterling, have risen to sixty, and the shares which were at first of one hundred pounds sterling, have been sold at *thirteen* times that sum! The capital first subscribed was 354,250*l.* sterling; the progressive extensions of the navigable line rendered new loans necessary, which have all been repaid out of the profits of the canal.

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* The great, says Massillon, are great only for other men; they enjoy their greatness only inasmuch as they make themselves *useful* to others; and they lose the right and title which make them great, as soon as they seek to serve themselves alone.

Principal Dimensions of the Grand Trunk.

Length ninety-three miles, of which sixty miles in the centre, opened in small section, with sixty-nine locks; then, in large section, first, on the side of the Mersey, eighteen miles, on the same level with the

Duke of Bridgewater's canal; second, on the side of the Trent, sixteen miles, with six locks.

Other Dimensions.	*Extremities.*	*Centre.*
Breadth at the surface of the water	35 feet to 40	25 feet to 30
Breadth at the bottom	18	16
Depth	5 6	4 6
Locks, 78½ feet breadth	15	7 6
Breadth of the boats*	14	7

The Grand Trunk canal presented much greater difficulties to overcome than that of the Duke of Bridgewater. It was necessary to direct it across a series of valleys and mountains, which have required the construction of thirty-five locks on one side of the Mersey, and of forty on the opposite, the erection of three aqueduct-bridges, and of 258 common bridges, the formation of five reservoirs, the excavation of five tunnels to traverse the great chain of hills which runs from the south to the north of England and Scotland. It was necessary to rise 316 feet above the Trent, and 408 feet above the Mersey. Moreover, not to be obliged to rise still higher, they were forced to give to the principal tunnel, bored in the pass of Harecastle, a length of 2888 yards. When the plan of the canal was originally made, they did not venture to open this tunnel in large section, which would have greatly increased the expense. It is for this reason, that the central part of the Trent and Mersey canal has been dug only in small section*.

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* The large boats carry forty tons; the smaller ones twenty.

The tunnel of Harecastle is only nine feet broad by twelve high, it is almost everywhere arched with bricks. It cost eighty-four shillings and sixpence per three feet. To attain the highest degree of economy, they have not even made a towing-path in this gallery. In order to pass it, each boat has two men, who, lying on their backs, push with their feet against the walls of the tunnel. Thus, two hours are employed in passing less than a mile and a half. This place is so frequented, that at the moment when the passage begins, a file of boats a mile long is often seen. To prevent confusion, those going to Liverpool pass in the morning, and those going in the contrary direction in the evening.

This accumulation of a traffic, too active for the locality, will render it necessary to make the canal broader, in order that a smaller number of boats, carrying the same quantity of merchandise, may occupy a smaller length and pass with greater rapidity. Thus it is already intended to open the canal in large section, in its central part as at the extremities, and to extend this improvement to the principal branches. If the abundance of capitals, accumulated during the last half century by the British merchants, and the prodigious activity which it has given to the conveyance of merchandise, now make the dimensions of part of the Grand Trunk canal much too small, for the wants and the resources of an industry, which has become gigantic, we must not, for that reason, blame the members of the company who first conceived, upon a modest plan, their judicious undertaking. Let us rather praise them for the precautions, excessive as they may appear, which they have taken to insure success to their speculations, in reducing as much as possible the original expense.

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* The canal has four other tunnels, of which the following is the situation and the length. Preston-on-the-Hill, 3730 feet; Barnton, 1716 feet; Saltersford, 1050 feet; Armitage, 390 feet. All four are thirteen feet broad, and seventeen feet high.

We should reflect, that it was this spirit of economy to which was owing the success of the first speculations, which, had they failed, or even been less profitable to the projectors, would have sufficed to disgust the public with the hydraulic ways offered to commerce for the conveyance of their merchandise. This remark is the more important, because in the present state of French industry and commerce, canals upon too expensive a scale ought not to be undertaken. Opulence and splendour are only safely to be attained by the steps of modesty and circumspection.

Following the course of the Grand Trunk canal, setting off from that of the Duke of Bridgewater, we first cross the tunnel of Preston-on-the-Hill, we then proceed by the side of the salt-works of Northwich, Nantwich, and Harecastle, near the great tunnel situated at its highest level; in coming out of this tunnel we enter the valley of the Trent, where the canal follows a course parallel with the river. Contiguous to this is the beautiful manufactory of earthenware known under the name of Etruria, founded by the celebrated Wedgwood, at the time of the first opening of the canal.

Iron rail-ways convey, on different points of the navigable line, the produce of the quarries, mines, and neighbouring manufactories. The first branch of the Grand Trunk canal, in length about eight miles, goes to Newcastle-under-line, famous for its hat manufactory; then re-ascends to Cheddleton, in the midst of a county full of manufactories of every species of earthenware, known by the name of Staffordshire wares. On the left bank of the Grand Trunk, another branch, in length twenty-eight miles, and continued also by three miles and three-quarters of iron rail-way, goes south to the town of Uttoxeter, and northwards to that of Leek, traversing a country rich in all kinds of manufactories.

At Haywood, in the vicinity of the town of Stafford, we find on our right the entrance of the Worcester canal, which descends to the Severn. We pass the Trent, over an aqueduct, then a tunnel, and we arrive at Fradley, at the southernmost point. Here begins the canal of Fazeley, which communicates with those, of which Birmingham and London are the centre. Here also, the Grand Trunk, leaving the direction of the south-east, turns suddenly to the north-east; crosses the Trent, and follows the left bank of the river to Wilden-ferry, on the Derwent, a river which flows on to Derby.

The canal of Derby is formed of three branches, which, re-unite in this city, and lead, the first, towards the south, to the Grand Trunk, which it crosses, to fall into the Trent at Swarkstone; the second, to the north; the third, to the west, to the canal of Erewash; total length, sixteen miles. Thus, including the Derwent, there are four navigable lines, proceeding from a town whose industry is much benefitted by them. The stream of this river is likewise very serviceable to the silk and cotton manufactories. It was at Derby, on this same river, that, in 1718, the first mill for winding and twisting silk was erected by J. Lombe, a native, who stole the secret of this art from the Italians, and who, it is thought, was poisoned by them. The period of his patent of importation having expired, the Parliament granted to his heir a national gift of 14,000*l.*, provided that he should make a complete model of the new mechanism, for the benefit of the public. Derby has many manufactories for silk stockings and porcelain; native marbles, metals, *&c.*, are also wrought, all which productions of industry find a most convenient and economical outlet, by means of the inland navigation.

The canal of Erewash, parallel with the river of that name, brings to the Trent the produce of the coal mines of the higher part of the county of

Derby; its length is eleven miles and three-quarters, upon a descent of 154 feet. Its branches are, first to the west, the canal of Nutbrook, constructed by two proprietors, extending five miles; secondly, to the north, the canal of Cromford, of which a branch is continued by an iron rail-way, as far as Mansfield; thirdly, to the east, the canal of Nottingham, which terminates at this town, on the Trent, but which is continued below this river by the canal of Grantham. The sight of this humble town should inspire us with feelings of respect: Newton acquired at Grantham the first principles of a knowledge, which was one day to explain the laws of nature.

Nottingham, in the centre of so many canals, re-unites all the means of a prosperous and varied industry. For twenty-five years it has produced lace, shawls, spun cotton, silk, *&c.* This town is celebrated for its stocking manufactories; its wealth and population increase with its manufactories and means of exportation. In 1811 it only reckoned 34,253 inhabitants; ten years afterwards, it had increased to 40,415. Above twenty years ago, when it had scarcely 30,000 inhabitants, it was the centre of a formidable conspiracy of incendiaries, and of frame breakers, because the mechanic considered these machines as the causes of his misery. The conspiracy once destroyed, the manufactories became more numerous, the population increased one-third, notwithstanding which, the general comfort is greater than before—thus, experience justifies the use of machines consecrated to industry, for the good of society.

Beyond Nottingham, still descending the Trent, we find, on our right, the most ancient canal in England, it is the *Fosse Dyke*, excavated by the Romans, filled up in barbarous reigns, and again opened in modern times. This canal extends as far as Lincoln, where it terminates the navigation of the ancient Witham.

At Stockwith-upon-Trent begins the canal of Chesterfield, a manufacturing city, surrounded with coal and iron mines, the produce of which is exported on this canal.

The length of this canal is nearly forty-five miles. It is in great section only, in the first five miles, from Stockport to Pusford. From the Trent to the highest part, its ascent is 335 feet; a tunnel is also passed, 3000 yards in length, after which we descend forty-five feet, down to Chesterfield.

Communications of the North-West.

The canal of Leeds and Liverpool, opened in great section, with a depth of water equal to four feet and a half, on forty-two of breadth—it is important from its extent, and the resources afforded in the counties it traverses.

It is 130 miles in length, and communicates by the Air, and the Ouse, with the bay of the Humber, Hull, and the German Ocean; it commences at Liverpool in a basin, whose waters are fifty-two feet above the lowest tides of the Mersey; from thence to the culminating point the canal ascends 430 feet, it is conducted by means of a tunnel, in length 1550 yards, in breadth eighteen feet, and seventeen in height; and lastly, as far as Leeds, it descends 410 feet.

To follow the canal of Leeds and Liverpool, setting off from this last town, we first go towards the north, we turn to the east, to enter the valley of the Douglas; a branch conducts to the north, towards the mouth of this river. We continue to ascend parallel with the Douglas to Wigan, the parish of which contained, in 1821, 36,818 inhabitants, a population which the coal mines and manufactories enable to live in opulence. From Wigan we ascend to the north, then to the west, to Blackburn, a manufacturing city, where silk-yarn manufactories, weaving, and bleachings, are very prosperous. The parish of Blackburn alone contains 53,350 persons. Advancing to the west we arrive at Beverley, another town, rich in its manufactories, and in the mines worked in its neighbourhood—we return to the north to proceed to Colne, near to the highest part of the canal. The great increase of population of the different cities we have surveyed is quoted in the last estimate of trade, published by the British Parliament, as the result of a *manifest improvement*, for some years past, in the manufactures of Lancaster. In coming out of the tunnel of Foulridge we enter into the county of York, still advancing a little to the northward; at last we return to the south-east, to Leeds, visiting in our way Skipton and Bingley.

Leeds is one of the most interesting towns in England, by the great appearance of industry which it displays—it has assumed for armorial bearings two of Minerva's birds, because this goddess presided over the weaving of silk and wool, as well as over other useful arts—arms which, by-the-by, are worth all the rampant lions, griffins, and *saltiers*, which the heraldic art ever invented.

Leeds is the centre of orders for, and the principal market of, woollen cloths manufactured in the west of the county of York, a county, of which it is (if we may thus express it) the commercial metropolis. The building which is used as a depôt, and as a place of sale for coloured cloths, is 380 feet long by 180; it has six double rows of stalls, and is the Palais Royal of mercers, and, what will certainly appear incredible to our dealers in stuffs of the streets of St. Dennis and the Halle, this building is celebrated for the perfect manner in which it is lighted! The internal police and regulations, by which sales are carried on in this beautiful establishment, are not less remarkable than its architecture. The trade of white woollen cloths occupies a less spacious building; it contains, nevertheless, 1210 shops; the former one 2000. I do not mention various other branches of trade, important in themselves, but secondary for Leeds. This city has a public school, with one hundred and twenty presentations; a school on the Lancasterian plan, for 1000 children; schools of industry and sunday schools, two commercial and political newspapers, more important than the *Moniteur*, a *Journal of Science, &c.* Such are the intellectual resources of a population, which, in 1811, was reckoned at 62,534 inhabitants, but which now amounts to 83,796!

Communications of the North.

Canal of Lancaster.—It derives its name from the county, which it traverses lengthways, passing through districts rich in fossil coal, and other useful minerals; it was begun by Brindley, continued by Whitworth, and completed by J. Rennie. It is suited to large barges*. It is seventy-five miles and three-quarters in length. It commences to the south of West-Houghton, leads to Wigan by a short branch, crosses a tunnel at Chorley†, descends 118 feet by an inclined plane, traverses the Ribble over an aqueduct at Preston, a town remarkable for the perfection and the excellence of its silk yarn and cotton-weaving machines. In proceeding still towards the north, we come to Garstang, and arrive at Lancaster, which was, as its name indicates, a Roman station. Near this city is a beautiful stone aqueduct constructed on the Loyne, by J. Rennie; it has five arches, each of which are in span seventy feet, and sixty-four in height. To the north of this aqueduct, the canal passes to Burton and terminates at Kendal, in the county of Westmoreland. In treating of sea-ports, we shall give ample descriptions of all the towns we have just mentioned.

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* Its depth of water is seven feet. It is intended for boats fourteen feet in breadth, and carrying sixty tons.

† There is another tunnel near Kendal.

CHAPTER IV.

Water Communications with London.

SUPPOSING us to leave the capital in a boat laden with merchandise or with passengers, let us examine the different ways we are to follow. On the east, we have only the lower course of the Thames; this route belongs to the sea and coast navigation, explained in the following volume.

Communications with the North.

These are made by the Lea which communicates with the Thames at Limehouse, an eastern suburb of London.

The first works executed to render the upper part of this river navigable, consisted only in a few dams, intended to procure a sufficient depth of water. In 1767, they consulted Smeaton on these imperfect works; they then built *locks*, at the same time that a lateral canal was made.

In ascending the Lea we find, on the right bank, a little stream, which leads to Waltham Abbey, the chief gunpowder manufactory of government. (See *Military Force*, vol. 2.)

Continuing our navigation, we arrive at Ware, one of the richest markets for the corn-trade. Every week it supplies, for the consumption of the capital, more than 7500 sacks of oats and wheat. This agricultural produce is seen descending in barges, which return laden with fossil coal. Near to Ware, we perceive on the right bank, the feeder of the aqueduct of the new river.

We ascend from Ware to Hertford, capital of the county of this name; this town has but 4265 inhabitants. We must here stop to observe an endowed school of the Blue-Coat Hospital of London, where the charity of the founder educates, maintains, and clothes gratuitously, 500 children! Nor must we forget the beautiful college, where the East India Company has provided for the instruction of young gentlemen, intended for the civil government and commerce of Hindostan. Professors, such as Malthus and Mackintosh, are the ornaments of this college.

At Hertford terminates the navigation of the Lea. It is proposed by means of a canal, to join this river with the Cam, which gives its name to Cambridge, celebrated for its University.

The Cam falls into the Ouse, and descends to the port of Lynn Regis, on the south bank of the bay of the Wash.

As the junction of the Cam with the Lea has not been yet effected, we must re-trace our steps. Nearly on our re-entering the Thames, we find a short cut which leads to the head of the Regent's Canal, on the left bank of this river. It is also near this point, that the canal which intersects the Isle of Dogs opens.

Communications with the North-West.

The Regent's Canal.—It encompasses, from the east to the west, the north of the capital, and is the point of departure of a long chain of canals, which go to Hull and Liverpool. It is open in great section.

Its breadth at the level of the water, is 45 feet, and 30 feet at the bottom, in a depth of water of five feet. Its length is eight miles, and its total ascent is 84 feet, the breadth of the towing-path is twelve feet; a foot-path, on the opposite side, three feet in breadth, is peculiar to this canal.

To follow the canal, in setting out from the south bank of the Thames, at Limehouse, we ascend immediately by three locks; we pass under the great and beautiful Commercial Road, which leads to the East and West India Docks. We ascend successively by five other locks, in going round the city. Arrived near the suburb of Islington, we traverse a tunnel, in length 896 yards; we pass over a deep cut, we reach the Hampstead road, and ascend again by four locks; we then follow the north skirt of the Regent's Park, and find on our left a branch of the canal, which proceeds to the east of this park, and terminates in a spacious basin. The ships employed in the navigation of the Thames, and also coasters, may enter this basin, which becomes a centre of trade for the north of the capital. From this basin, the canal is on the same level as far as Paddington. To preserve this level, it was necessary to make considerable cuts, and excavate a tunnel, in length nearly 440 yards.

The Regent's canal, which must be supplied by the waters taken from the Thames, by means of steam-engines, is now to be fed by the company known by the name of "*The Grand Junction Waterworks Company.*" For the future, this company will draw directly from the river Thames, the water with which they supply the inhabitants of London.

This canal, though not very extensive, presents nevertheless numerous works of art. Thirty-seven bridges cross it; it passes under the aqueduct of the New River: it has, as we have seen, two tunnels, which, similar to most of those constructed for English canals, are without a towing-path. (See plate.)

It is surprising, that, as yet, a simple and easy mechanism has not been invented to enable the boat's motion to be as rapid in passing the tunnel, as on the open canal. It is a problem of great utility, which we propose to the abilities of English engineers.

General Congreve had prevailed upon the company to allow a double lock to be erected on the Regent's Canal, he gave it the name of *hydropneumatic,* because the power of air and water were combined to raise and sink, alternately, two floats, on which were to rest the boats about to ascend and descend. This plan was deemed ingenious, but too complicated, and liable to be deranged; it was therefore abandoned.

They have constructed on the same canal, a double lock more simple, and which generally may be advantageously employed. The contrivance is as follows:—

By means of a pipe under ground, which a flood-gate opens or shuts at pleasure, a communication is established between the two locks. Let us now suppose the water in one of the locks to be on the same level as that in the canal above; and the water in the other lock, likewise on the same level as that of the canal below. In raising the flood-gate of the above-mentioned pipe, the height of the water in the two locks will then be only half what it is in the upper and lower parts of the canal. Hence, if the boat is to ascend, it will only be requisite to let in the lock a quantity of water, equal to the half-difference of the level we have just noticed; if the boat descends, the same quantity of water will be sufficient. Thus, in both cases, the consumption of water will be half what it is in general. (See plate.)

Canal and Basin of Paddington.

It is at this basin, that the canal of the same name begins, and the Regent's terminates, Paddington, till lately, was but a village, but the new water-ways that traverse it, have made it an important place. Numerous buildings have united this village with the metropolis, of which it is now a rich, well-built, and handsome suburb. The basin of Paddington is not less than 400 yards in length, and 290 yards in breadth. Rows of wharfs and sheds rise parallel to the quays of this commercial port. Finally, near the same quays, large spaces of ground afford accommodation for the public sale of the agricultural produce, brought hither by the inland navigation.

The Paddington canal is thirteen miles and a half in length, on one level; it is generally fifty-nine feet wide; this width increases to 130 feet, in places allowed for the accommodation of barges which may happen to be detained by some cause or other. On each side, the space reserved for the towing-path and the embankment, is thirty-six feet.

The Paddington and Regent's Canal have, with regard to London and the Thames, the same destination as the canals of St. Dennis and of St. Martin will have for Paris and the Seine; but in order that these should produce the greatest advantage to Paris, it were requisite that a branch extending to the north-west of the capital should terminate in a vast basin, which would become like that of Paddington, the inland port of the richest and most beautiful part of our metropolis.

The Grand Junction Canal.

This is the principal line, of which the Paddington canal is only a branch—it is ninety-five miles in length; it proceeds from the Thames to the Oxford canal, traversing the counties of Middlesex, Hertford, Bedford, Buckingham, and Northampton, which all communicate with London through it. It passes by nineteen towns, and its branches lead to many manufactories, which owe to it their origin and prosperity. The great usefulness of this canal is the very source of its wealth.

About twenty years ago the company to which it belongs had a capital amounting to 1,125,000*l.* sterling, and it has now expended above 2,000,000*l.*; its shares have considerably increased in value since the completion of its most important improvements, in 1805, having risen from 100*l.* to 210*l.* The profits would have been greater if the shareholders had not had to pay annually, first, 600*l.* to the city of London, to indemnify the corporation for the loss experienced in a revenue derived from a toll on the Thames, between London and Brentford, in consequence of the navigation on the Paddington canal. Secondly, the sum requisite to make the Oxford canal produce annually 10,000*l.* This respect for the property of others should be cited as an example; it would be easy to show mathematically that it is founded on true principles of political economy.

The breadth of the canal at the surface is thirty-six feet, at the bottom twenty-four feet, the depth of water four feet and a half, lock's length eighty-six feet, breadth fourteen feet and a half; some of its branches are only in small section, that is to say, for barges seven feet wide.

In the excavation of a canal, running across a country very hilly and uneven, there were many difficulties to overcome, much levelling and many works of art to execute. It was begun by Wm. Jessop and finished by Mr. Telford. On quitting Brentford we soon leave the valley of the Brent, to arrive at that of the Colne, which we ascend in a northern direction from the south, passing by Uxbridge, a town famous for its corn market: passage boats go every day from Uxbridge to Paddington. On ascending, we perceive, on the left, the town of Rickmansworth; on the right, the spot where a projected arm is to begin, and to establish a communication between the Canal and Watford, a little manufacturing town, and St. Albans, formerly celebrated for a beautiful monastery of which it has retained the name. Near it, was the ancient city of Verulam, from whence Bacon had his title, as a peer of England.

The principal line of the Grand Junction Canal leaves the valley of the Colne, near the entrance of the intended branch of St. Alban's, and ascends into the Valley of the Gade; Hemel-Hempstead, one of the most considerable corn-markets in the county of Hertford, is seen on the right. We proceed to Berkhampstead, a manufacturing town; we arrive at the first highest point, which is 402 feet above the Thames; we traverse a summit level formed by considerable cuts, on an extent of three miles and three-quarters. At this point a navigable branch, extending westerly, terminates at Wendover; from Marsworth, another branch, still westerly, reaches Aylesbury, a manufacturing town, situated in the fertile valley watered by the Ayle; some day this canal will join with the higher part of the Thames, and continue till it arrives at the town of Abington, to unite with the canal of Wilts and Berks, which forms one of the principal communications of London with Bristol.

In navigating on the Grand Junction Canal we descend 192 feet, on an extent of thirty-five miles and a half, following the vale of the Lyssel, which falls into the Ouse at Newport Pagnell; near to the confluence of these rivers the canal retrogrades, to ascend the Ouse by a branch, till it arrives at the town of Buckingham, capital of the county of that name. Then, it quits the valley of the Ouse to follow that of the Teme, passing over a causeway twenty-nine feet and a half in height, and two miles and a half in length*; then on a sheet iron aqueduct: we then ascend 112 feet, in an extent of six miles and a half, and pass near Blisworth, a considerable mountain, by a tunnel; formerly the boats passed this mountain by means of two inclined planes; but they have been replaced by a tunnel 3080 yards in length, and sixteen feet and a half in breadth; at each end of this tunnel, and for some distance †, the sides and bottom of the canal are of masonry; a little further we find to the right the branch which descends to Northampton, capital of the county of that name; the Nen is navigable from this town to the bay of the Wash. Thus, when we set out from London, instead of descending the Thames, and exposing ourselves to the tempests of the sea, along the coasts of Essex, Suffolk, and Norfolk, we have only to embark at Paddington, on the Grand Junction Canal, to arrive at Northampton, and to descend the Nen. Northampton, situated in the centre of a county, fertile in beautiful meadows, is the most celebrated market for horses in England; there are manufactured for exportation quantities of shoes, harness, &c. In 1821 the population of this town was 10,793 inhabitants, one-fifth more than in 1811.

The Grand Junction Canal, which ascends from Blisworth, follows the valley of the Nen, then abruptly turns north-west. On the left, we find the short branch which leads to Daventry, the culminating point of numerous canals; at three miles from Daventry, the Grand Junction Canal, traversing the tunnel of

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* Safety-gates are established upon this causeway, as well as upon several others belonging to the same canal, as has been practised with the Duke of Bridgewater's.

† A little below the water mark, the coating of masonry of the tunnel is protected by timbers laid horizontally and projecting much every ten feet; strong kevils, or pegs fixed upon these guards, are used as points of support in towing the boats.

Braunstone, being there 170 feet above the Ouse, rejoins the Oxford canal, in descending sixty feet. The Braunstone tunnel is 2045 yards in length; the other dimensions are those of the tunnel of Blisworth.

Large ponds and five vast reservoirs supply that part of the canal which is the most elevated; besides, a steam-engine raises again a part of the water spent in opening and shutting the locks. The other summit level is fed by a side cut, and is itself so excavated as to serve for a reservoir. Finally, the waters, wasted by the locks on the side of the Oxford canal, are in part restored in this division by a steam-engine. A similar machine is erected near Two-waters, below four succeeding locks, and restores the waters spent in working them. Here, the English avail themselves of a method as simple as it is ingenious, practised at first in Flanders, to economise the water. Basins are formed near each lock, at the extremity of the intermediate part of the canal, as has been practised by the side of the twelve locks which serve to descend from Norwood to the Thames. These basins, divided into three reservoirs, in three different heights, receive the water of the locks by pipes which correspond with these respective heights; by this means water is let down the canal as little as possible, in the descent of boats. If, on the contrary, a boat is to ascend, the water thus reserved is re-introduced in the lock.

The Grand Union Canal.

A short time before arriving at Daventry, when, in coming from London, we follow the Grand Junction Canal, we find, on the right, the Grand Union Canal, constructed between 1810 and 1814: it joins directly the first with the principal line of communication from Hull to Liverpool.

The Grand Junction Canal is in the direction of north to south; it is twenty-three miles in length. Traced in a very high country, it has tunnels of considerable extent; that of Crick is 1524 yards in length; that of Bosworth is 1166 yards—they are in great section, but the locks of this canal are in small section. To follow in large boats the navigable line which we are about to trace, from London to Hull, it would be requisite to re-construct these locks.

The Union Canal, began in 1793, unites the towns of Leicester and Northampton. It is finished for an extent of twenty-three miles only, from the former town to Market Harborough. Leicester, the capital of a county, a manufacturing town, which, in 1811, had a population of 23,146 persons, and which, ten years afterwards, reckoned 30,125, was, for this augmentation, partly indebted to the completion of the fine line of canals we have traversed; a work completed during those ten years.

At Leicester, the river Soar becomes navigable; it receives, on its left bank, the Mowbray, which we ascend in boats to Melton Mowbray. Here begins the

Oakham Canal,

which terminates at Oakham, the principal town in the little county of Rutland. This canal is fifteen miles in length. In returning by the Soar, we find, a little lower than the mouth of the Mowbray, the line of Leicester Canal which completes the said navigation from Leicester, continued by that of Loughborough, which leads to the Trent, opposite to the entry of the Canal of Grewash. Between Leicester and the Trent, these two navigable lines are altogether thirty-one miles in extent.

Such is the new water way, at once the most direct and convenient, between the two ports of Hull and London; a line, however, that was not completed till within the last three years.

The Canals of Oxford, Coventry, and Fazeley.

These form an unbroken chain, from the Thames to the Grand Trunk Canal, traversing the counties of Oxford, Northampton, Warwick, and Stafford, rich and populous counties; which find, for their agricultural produce, their mines and manufactures, an opening extremely favourable, by the navigable ways we are about to describe.

Oxford, a city with 16,364 inhabitants, opulent in itself and famous for its university, is not less worthy our notice for its commercial position, at the confluence of the Thames and the Charwell, than as being the point where the great roads, which lead from London to the West of England, cross each other.

The Oxford Canal is ninety-one miles in length. In this extent, it comprises more than 250 bridges; one of its aqueducts (Pedlar's Bridge) is formed of twelve arches, each twenty-two feet in span; it has forty-two locks, in length seventy-five feet and a half, and seven feet wide, at the bottom between the doors; in other parts of the canal, its width is twenty-eight feet at the surface of the water, and sixteen at the bottom; the depth of water is four feet and a half. This canal was formed very slowly, on account of the want of funds. Began in 1769, it was only finished in 1790.

On leaving the Thames, we ascend the Oxford Canal by locks, the rise of which is only three feet and a half; we proceed along the Charwell, and pass, from its right bank, upon the left. We arrive at the culminating point, after having ascended 192 feet by twenty-nine locks, on a length of canal of thirty-four miles and a half. We meet in our road with Banbury, a town famous for its plush manufactories.

The part of the canal, between the ascent and the descent at Fenny Compton, is about eleven miles in length; it passes through a tunnel 1188 yards long, nine feet and a half wide, and 15½ feet high, across a chain of hills which separate the *basins* of the Thames and the Severn. We then descend fifty-five feet by nine locks, on an extent of one mile and three-quarters; here, we find a steam-engine which serves to force up again a part of the water spent in the working of the locks, and which is intended to supply the deficiency of the reservoirs, in case they should fail. We then see nearly seventeen miles on the same level; we arrive at Napton, and we see on our left the entrance of the Napton and Warwick Canal. We descend eighteen feet, by three locks on a length of 875 yards, to Hill Morton; here, we find again a steam-engine employed to force up the water. Finally, the Canal of Oxford exhibits a line of twenty-six miles, on the same level, till it reaches the Coventry and Faseley Canal.

The Coventry and Fazeley Canal.

This canal is thirty-two miles in extent, in one of the most elevated parts of the centre of England—it commences at Coventry, a city which, at the last census, contained 21,242 inhabitants, chiefly engaged in the manufacture of gauzes, ribbons, and other kinds of mercery. From Coventry to Longford, where the Oxford canal terminates, that of Coventry is three miles and a half in length. A safety-gate is placed at the junction of the two canals, to prevent the loss of water in the latter, in case the banks of the former should give way. A little further, before coming to Nuneaton and then to Atherston, towns which carry on the same trade as Coventry, we find, on the right, a considerable arm, known by the name of Ashby-de-la-Zouch*, and on the left a great number of other very short branches leading to rich coal-pits. Further, we turn to the west and south-west, and we descend ninety-six feet, by three locks; we traverse the Tame on an aqueduct, and arrive at Fazeley, where the canal of this name begins, which is on a level, till it reaches the Grand Trunk Canal.

Distances.—From Coventry to Atherstore sixteen miles, on the same level; from Atherstone to Fazeley ten miles, with a fall of ninety-six feet, by thirteen locks. From Fazeley to the Grand

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[*] This branch is thirty miles and a half long; it ascends 140 feet, and descends eighty-four.

Trunk eleven miles on the same level, of which the last belong exclusively to the company of the Coventry Canal, the other belong to the Birmingham Canal. The latter obtained the property, because the first city discontinued for more than ten years working in this part of the country. Dimensions of the canal—width at the surface of the water, twenty-eight feet; at the bottom, twenty-six feet; height of water, four feet; lock's length, seventy-four feet; width of the gates, seven feet.

The original shares of this canal were 100*l.*; they have risen to 400*l.* The formation of many other canals in the county of Warwick has rather lowered the value of the shares, but they have nearly recovered their former value since the opening of the Grand Junction, which was only finished in 1793.

It is now we perceive, in all its extent, the utility of this last line of navigation.

The Oxford Canal was commenced as early as 1769—thus, during a period of twenty-four years, the only communication carried on by exterior navigation, between London and the two great ports of Hull and Liverpool, was by making an immense circuit. It was requisite, for that purpose, to ascend the long, winding, and difficult course of the Thames between the capital and the city of Oxford. After 1793, it was sufficient to follow this river the short distance which separates London from Brentford, to reach there the direct line of the Grand Junction Canal; but, at the present time, we can set out even from the Port of London, leaving altogether the Thames, avoid all its bridges, go round the northern part of the capital, and reach, by means of the canals, either the Trent or the Mersey, according as we intend to go to Hull or Liverpool.

Communications with the West.

They all unite at the head of the Thames, of which the principal branch is also named the Isis. We shall examine them in continuing to turn from the north to the south. If we ascend up to Lechlade, a place where the Isis ceases to be navigable, we find the canal of the Thames and the Severn open in large section, to join the two rivers of which it has received the names. It is the work of Clowes and Whitworth, who completed it in 1789.

Let us embark on this canal, at Lechlade, where it begins *. In traversing twenty miles, we ascend 131 feet, by sixteen locks, to the culminating point. We observe, on our right, a branch, eighteen miles in length, leading to Cirencester, a manufacturing town, containing 5000 inhabitants. On arriving at the highest part of the principal line, we traverse the great ridge of mountains which divide England from north to south; we enter the tunnel of Sapperton, 4300 yards in length and fifteen feet in breadth; it is one of the finest specimens of works of this kind. It has a coating of masonry with an inverted arch for the bed of the canal, excepting in those places which are cut through the rock. From the tunnel we descend 241 feet, by twenty-eight locks, on an extent of seven miles and a half, and reach the town of Stroud.

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* The boats which are used are of a burden of fifty-six tons, eighty feet long, twelve feet wide, and draw three feet and a half. The canal is forty-two feet wide at the surface of the water, twenty-eight at the bottom, and is five feet deep.

The Stroud Canal is the continuation of that which we have just described; it goes to join the Severn, in following a course parallel with that of the river Stroud, whose waters are excellent for the dyeing of woollen cloths; and we see consequently, along the banks of this river, numerous manufactories for the weaving, fulling, and dyeing of these stuffs in cloths. The manufacturers on the banks of the Stroud opposed as much as they could the formation of this canal. Through them, the first undertakings failed, which, besides, were rendered unsuccessful, on account of their making use of cranes, to convey the goods from the pound of one mill into that of the next, a method which had been adopted to avoid the waste of water, but which they were obliged to abandon, as too slow and expensive.

At the present time the Stroud canal, on a length of seven miles and a half, descends 102 feet, through nine locks. It is on still larger dimensions than that of the Thames and Severn; it is able to admit boats of seventy-five tons burden, sixty-six feet in length, sixteen feet in breath, and five feet deep.

The Berkley and Gloucester Canal.

In some French work this canal has been erroneously represented as completed and navigable. It is intended to make it cross that of the Stroud*, near the Severn; it will serve as a lateral canal to this river, so sinuous in this part of its course, that twenty-eight miles of navigation on the river will be replaced by eighteen miles and a quarter of artificial navigation, by means of two large locks, opening in the Severn; one at Berkley, a little trading town, the other at Gloucester, an opulent city with 9744 inhabitants. This population will increase when they have completed the canal, which having eighteen feet of depth of water, and sixty feet in width at the surface, will be navigable for large trading vessels. It is much advanced. The direction of the work is confided to Mr. Telford.

The Hereford Canal.

We pass the Severn at Gloucester, and enter the Hereford canal, which, towards the north-west, ascends the valley of Liddon. We then traverse eighteen miles to Ledbury, a town famous for its rope manufactories and breweries. The remainder of the canal is yet in contemplation.

At the distance of eight miles and a half beyond Ledbury, it will attain the culminating point, 196 feet above the level of the Severn; it will descend thirty feet in an extent of nearly three miles; find six miles on the same level and reach Hereford. The canal will have three tunnels, one 2,192 yards long, the other 1,320, and the third 440.

Hereford, which gives its name to this canal, as

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[*] In order that the works of the new canal may at no time injure the navigation of that of the Stroud, the share-holders of the former are compelled to construct safety flood-gates near the place where the two canals intersect each other.

well as to one of the counties in Wales, is not deficient in industry. Its chief manufactures are gloves and flannel; it has 9000 inhabitants. This population would rapidly increase if the canal were completed, or if they improved the course of the Wye, which leads to the Severn, and which is navigable as far as Hay, the boundaries of the counties of Hereford and Radnor. The Lugg which passes by Leominster, is another river which falls into this, a little below Hereford.

Let us now re-join the Thames at Abingdon, below Oxford, and visit the most northerly canals which serve to communicate between London and Bristol.

The Canal of Berks and Wilts.

It has its name from the two counties it passes through. Abingdon, where it commences, has 5000 inhabitants; this town derives part of its wealth from the manufacture of canvass, sacks, and malt.

Upon quitting this town, the canal proceeds to the south-west, passes Swindon, ascends 199 feet, on a distance of twenty miles, and then presents a line of eight miles on level ground; then it descends 165 feet, and comes very near to Semington, to join the canal of Kennet and Avon, which connects London to Bristol.

The canal of Berks and Wilts is fifty-two miles in length, twenty-seven feet and a half in breadth at the surface, fourteen feet at the bottom, and four and a half deep. It is open in small section, for boats seventy feet long, and seven feet wide. In following this canal, we observe on both sides, three branches leading to the towns of Chippenham, Calne, and Wantage. In 1812, it was in contemplation to open from Swindon to Cricklade, the north Wiltshire canal, to unite the one we describe with those of the Thames and the Severn.

Canal of the Kennet and Avon.

As we turn to the south, the canals depart from less elevated points of the Thames. The canal of the Kennet and Avon begins much below Abingdon, at Reading, the chief town of the county of Berks. This town which contained, in 1821, 12,867 inhabitants, has many manufactories, and is the market of a very extensive inland trade.

To visit the canal of the Kennet and Avon, we navigate immediately on the Kennet, from Reading to Newbury, a town of 5,367 inhabitants. We enter in the part of the canal which is terminated*. Hence, to the highest level, we travel sixteen miles and a half, in ascending 212 feet. The part which divides the ascent and descent is two miles and a half in length; it passes through a tunnel 700 yards long. We descend thirty-three feet by four locks, on a space of fifteen miles; and we then traverse fifteen miles on level ground; then, we descend 295 feet, till we meet the Berks and Wilts canal; then, we traverse five miles on the same level; we descend ten feet, by one lock at Bradford, where will begin a canal, which is to pass, on the south side, the county of Dorset, and open on the coast which looks to France, through the Stour. A little on the side of Bradford, we find on our right, the branch known by the name *The Somerset Coal Canal.* It is eighteen miles in length, it proceeds, as its name indicates, to coal-pits, of which it brings the produce to the canal of the Kennet and Avon. On setting out from Bradford, we follow a level of nine miles. In the last 1,750 yards, we descend sixty-six feet, by means of seven locks, and we arrive at one of the most beautiful cities of England.

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* It had been the intention to lower the summit level, by means of a tunnel, in length 5000 yards. To avoid this immense labour, they have preferred to ascend by four high locks, and to supply, by a steam-engine, the want of the usual resources afforded by rain water; a resource unavoidably lessened in proportion as the site is more elevated.

Bath is not a trading town, but one of great consumption; it has 37,000 inhabitants. The celebrity of its baths, the beauty of its situation, the mildness of its climate, the magnificence of its edifices, and the variety of its amusements, attract, from all parts of Great Britain, the valetudinarians and the rich idlers; they circulate much money in this city and its neighbourhood. Bath is on the banks of the Avon, which passes by Bristol. A canal, parallel to this river, establishes a communication between these two towns, and completes the line* we are now examining. This canal has rendered the construction of many beautiful works of art necessary; among others, two aqueducts, built of stone, upon the Avon; it is one of the principal works completed by Rennie. Begun in 1794, it was finished in 1805.

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* In all this line, the canal is forty-five feet in breadth at the surface, and five feet in depth; it is in large section, and its locks are eighty feet long, and fourteen feet wide.

Communications of the South.

If we ascend the Thames to the confluence of this river with the Wey, between Staines and Kingston, we find on our left the Basingstoke canal, which proceeds to the south-west in passing through the counties of Hants and Surrey.

We ascend 195 feet by twenty-nine locks, on an extent of fifteen miles; in following twenty-two miles and a half more, on the same level, we enter a tunnel which exceeds 1,100 yards in length. Near Odiham, we meet, on our right, a branch of six miles long, which leads to Turgis. At Basingstoke, where the canal terminates, five high roads meet. They weave and make handkerchiefs in this town. The inhabitants, besides, carry on an extensive corn-trade from the produce of the adjoining country. This corn is taken hence to London by water.

It has been projected to continue the Basingstoke canal as far as Newbury, where it would meet that of the Kennet and Avon; a measure which would offer between the great ports of London and Bristol, a third line of communication, still more direct than the preceding ones*.

If we leave the Basingstoke canal on the right, to take our course directly up the Wey, we advance towards the south as far as Guilford. We ascend eighty-six feet and a half, on an extent of fourteen miles, passing some locks, the original construction of which is traced back as early as 1651; for these they are indebted to Sir Richard Weston, who first (they say) introduced locks and turnpike-roads in England. It was therefore under the republican government that great improvements of this kind began; but these improvements became more and more remarkable after the restoration.

From Guilford, we may again ascend the Wey by a lateral canal to Godalming†, ascending thirty-two feet and a half, on an extent of three miles and two-thirds.

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* Another canal, which it would be extremely useful to execute, would unite Basingstoke's to that of Andover, which has a descent of 177 feet to the bay of Southampton, on a length of twenty-two miles, and which communicates with that of Salisbury, of which the length is seventeen miles and a half. These last canals form a communication between three important towns, especially the two last. Andover has 4,123 inhabitants; Salisbury 8,763; Southampton 13,353. Salisbury is situated at the confluence of three rivers, of which the principal, the south Avon, is navigable as far as the sea, in which it throws itself at Christchurch bay.

† The traffic on this canal and on the Wey is carried on by boats, having seventy feet in length, and seven feet in breadth, and drawing two feet eight inches; they carry forty-five tons.

Between Guilford and Godalming, begins the canal of Wey-and-Arun, which re-unites the two rivers of which it has the names. In descending the Arun, we have, on our right, a stream of water, rendered navigable as far as Medhurst. This branch, which is fifteen miles in length, together with the lower part of the Arun, as far as the town of Arundel, is known under the name of the Arundel-Canal, and belongs to the Earl of Egremont. The Arun throws itself into the sea a little below Chichester, where the Portsmouth canal begins; by means of this canal, they avoid communicating by sea between these two ports. (See vol. ii.)

To complete the survey of the inland communications, of which London is the centre, we have now only to describe the canals of Surrey, of Croydon, and of the Thames and Medway.

The Grand Surrey Canal

Opens in the Thames, above and below London, the southern part of which it surrounds, from Rotherhithe to Vauxhall. By a branch, it was to have extended to the south, as far as Mitcham. It communicates with the Greenland dock, and the Croydon Canal*, which begins at Deptford.

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* At Croydon, a town which contained, according to the last census, 9,254 inhabitants, passes the double iron rail-way of Surrey. This way, one of the most beautiful of the south of England, is the work of William Jessop. It descends to the Thames, near

The Croydon Canal.

This last is nine miles and one-third long. It ascends, immediately, seventy feet by twelve locks, which are seen on the right from the road, which leads from London to Dover; about 1,100 yards further, it ascends again seventy-nine feet, by thirteen single locks and a double one. The last six miles are upon level ground; the length of the locks is sixty feet, and their breadth nine.

The Canal of the Thames and the Medway

Is only seven miles in length, but it is opened in large section; it is on the same level on its whole extent, and is supplied from the Thames, at high water. The gates, at the two extremities of this canal, have their frame made of iron, covered over with common planks; they are, in miniature, an imitation of the beautiful gates of the Caledonian canal, which we shall describe in the next volume. In coming out of the canal of the Thames and the Medway, near Chatham, and passing under Rochester bridge, we may ascend to Maidstone, and, in a boat, proceed to Tunbridge. It has been in contemplation to extend this navigation from east to west, by a canal which would allow vessels to pass from the

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Wandsworth, on an extent of ten miles; it ascends, in proceeding from Croydon, to Godstone, on an equal length.

Medway to Portsmouth without going by sea. It does not seem, however, that the execution of so bold an idea has as yet been defined.

The thought has also been conceived of opening another canal from the Medway, between Maidstone and Tunbridge. It is to branch off eastward, to reach the town of Ashford, and, southward, to join the Royal Military Canal, which was begun during the war between England and the French empire, to present a vast defence, on all the accessible parts of the coasts opposite to France.

CHAPTER V.

Hydraulic Communications of Birmingham, Bristol, and Hull.

In Great Britain, there are two towns only, which, by the extent and activity of their industry, are worthy to be compared with Birmingham. These are Manchester and Glasgow. They derive their wealth more particularly from weaving. Birmingham derives her's entirely from the working of metals; from the smelting of the largest masses, to the formation of the most delicate trinkets of steel, copper, silver, and gold. It is at the entrance of this town, at Soho, that Watt and Boulton established their celebrated manufactory for steam-engines.

If Birmingham is distinguished for the great perfection of its mechanical productions, it is equally so, on account of the great attention its inhabitants give to the propagation of learning among the working class. Birmingham possesses a great number of elementary schools; three of its establishments, on the Lancasterian System, admit above two thousand children. It has Sunday-schools for children and grown-up people, charity-schools for the children of the poor, two libraries, literary societies, *&c. &c.*

It is impossible to contemplate without admiration, the rapid progress of Birmingham in industry, riches, and population. Within two centuries, its land has been centupled in value*. At the beginning of the seventeenth century, it had a population of 10,000 souls; 110 years afterwards, it reckoned 85,753; and ten years after this latter period, 106,722. Nevertheless, the increase of its population is much less astonishing than the activity of its manufactories. On viewing the immense quantity of goods which are sent out of the town to be scattered over all the markets of the universe, it is scarcely possible to credit that 22,000 families are sufficient for their fabrication. But the aid of machinery multiplies the power of man, and he thus joins the strength of inorganic nature to his own. In the part of these observations, which will explain the productive power of Great Britain, ample details will be given respecting a town in which this power shows itself with the greatest energy.

At present, it is our object to examine which are the public works undertaken to open a commercial intercourse between Birmingham, the places whence it draws its unmanufactured materials, and those to which it exports its produce. Eight high roads take their departure from that town, radiating towards the following places:—1st, Coventry, Daventry, and London; 2d, Warwick, Oxford, and

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* A school, founded by Edward VI., with a revenue of 30*l.* from landed property, receives at present, from the same estate, 3,000*l.* sterling.

London; 3d, Henley, Stratford, and Oxford; 4th, Worcester, Gloucester, and Bristol; 5th, Shrewsbury, Bangor, and Holyhead, opposite to Ireland; 6th, Wolverhampton, Stafford, and Liverpool; 7th, Litchfield, Leek, and Manchester; 8th, Litchfield, Nottingham, Leeds, York, and Hull.

The hydraulic communications are still more numerous. They furrow, on every side, the territory between the Grand Trunk on the north; the Oxford and Coventry canal on the east; the Avon on the South, and the Severn on the west. These outlets of Birmingham surpass in extent those even of Manchester. Without counting two rivers, the Tame and the Rea, which fall into the Trent, ten navigable canals, with numerous branches, present a total developement of 216 miles, in a radius of twenty miles, over which a pedestrian might easily walk in seven hours.

Communications with the North.

These are established by the canal of Birmingham and Fazeley*, opened in small section. This canal, which joins at Fazeley the Oxford canal, and at Fradley, that of the Grand Trunk, completes the system of communications between Birmingham and the ports and towns of London, Hull, Manchester and Liverpool. The canal, which forms the central link of this vast chain of inland water-communications, is so frequented, that the company of proprietors of the canal of Birmingham and Fazeley* have seen their shares rise in value, from 100*l.* to 2,000*l.* sterling! This is an instance of the greatest prosperity ever attained by enterprises of this kind, and this instance of prosperity is given by a canal of *small navigable dimensions.*

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* For boats of seventy feet long, by seven feet wide.

Let us follow this canal, setting off from Birmingham, in the quarter called Digbeth. It passes close by a portion of the town which it compasses in the west and north, and rises 125 feet by means of nineteen locks†, on a distance of nearly two miles. Here is the culminating point, where the old Birmingham canal begins. We now continue on that of Birmingham and Fazeley, which descends gradually. Traversing the Tame, over an aqueduct bridge, and arriving at the distance of eight miles and a quarter from Fazeley, we find ourselves 246 feet below the culminating point, after having passed through thirty-eight locks. The eight miles which separate us from Fazeley, as well as all the Fazeley canal, as far as the Grand Trunk, are on the same level.

Near the place where the canal of Birmingham and Fazeley meets that of the old Birmingham, there are two spacious basins surrounded with quays. The walls of the quays of one of the basins are covered with plates of cast-iron, joined by tenons and mortises and fixed to the masonry with screw bolts.

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* And of the old Birmingham canal.

† To resist the shock of the boats, the side of the locks have their guards covered with plates of cast-iron.

Communications with the West.

The old Birmingham canal terminates at the Staffordshire and Worcester Canal, established upon the most direct navigable line, between Liverpool and Bristol.

To follow the old Birmingham canal from the town of that name, we proceed at first four miles and a half on a level; then, as far as Smethwick, we descend eighteen feet by three locks. Here the activity on the canal is such, that it has been judged necessary to make a double descent with three locks, in order that the boats might not be retarded in their perpetual arrivals and departures. The principal line is continued afterwards on a level nearly till we join the Staffordshire and Worcester canal, but in the last two miles it descends 113 feet by means of seventeen locks. According to the old track, it made near Typton a circuit of four miles; a cut one mile and a half in length, of which 1000 yards are under ground, permits the boats, at present, to avoid this inconvenience. On the west of the canal, a navigable branch goes from Wednesbury as far as Walsall; it is about eight miles and a half in length.

The Walsall branch, and many secondary branches, which it would be too minute and useless to detail, lead to the vicinity of the mines of iron and coal, contained in the country, of which Birmingham is the centre. In traversing these different branches, one seems to be lost as in the midst of an aquatic labyrinth, so multiplied are they on every side. They are, moreover, admirably combined with rail-roads, offering outlets to so many manufactures, that they exhibit an admirable harmony between science and activity.

The whole country, of which we are describing the hydraulic communications, is covered with heaps of fossil-coal, turned by fire into coke,—high furnaces, and forges for the manufacture of iron—steam-engines used in the extraction of the iron and coals from the mines, and in draining these mines, the water of which, conveyed in the smaller canals, becomes useful to navigation. I have walked over this country in a dark night; the horizon about me was bounded by a circle of fire. From all parts, columns of smoke and flame rose in the air, and the whole country around seemed as if lighted by an immense conflagration. Vain would it be for me to attempt to describe the impression of this imposing sight, in which the most prominent image of destruction, fire, was the result of an industry, the productive strength of which shows the happy power which the genius of modern nations has obtained over nature.

The bed and banks of the secondary canals, opened upon the spot which we are now surveying, are formed with the earth proceeding from the excavations of the mines, and the scoria taken out of the furnaces.

To avoid filtration, the interior of these branches, as well as those of the principal canal, are lined with a thick layer of clay. These artificial embankments are sometimes twenty-six feet in height.

The act of parliament which established the old Birmingham canal company, authorized them to visit the neighbouring mines, in order to prevent the subterranean excavations being carried nearer than forty feet to the navigable line. Notwithstanding this provision, they have been obliged in many places to raise the banks of the canal, to remedy the sinking of the contiguous ground.

The proprietors of those mines which are not more than one mile distant from the canal, have a right to open a communication with it by a railroad. Beyond this distance, they open canals of communication, which are to be supplied independently of the main canal. Safety-gates, which are kept closed by the very pressure of the water of the principal canal, would prevent its running into any of the branches, in case an accident should happen.

The proprietors of the mines are obliged to turn into their respective branches the water drawn daily from these mines by the steam-engines. An idea may be formed of the magnitude of such works from the mine of Horsley, the property of Mr. Manby. The draining is performed by a machine of 100-horse power, at a depth of 660 feet. Notwithstanding the abundance of water thus furnished, and running into the old Birmingham canal, ten steam-engines are necessary to feed it*.

Three large reservoirs are formed on the culminating point of the Birmingham canal, and steam-engines return into the upper part of the canal a portion of the water spent in working the locks situated at each end; nevertheless, these supplies, added to all those enumerated, not being sufficient for the purpose, it was found absolutely necessary to lower the bed of this part of the canal, in order to be able to collect the water proceeding from the springs flowing, at a corresponding height, from the neighbouring hills. This circumstance may be attributed to the great loss of water arising in some places from the localities, or the filtration which takes place, notwithstanding the lining of clay put inside the canal, a fact already noticed in our remarks on the hydraulic communications of Manchester.

Canal of Wirley and Essington.

North of Birmingham and Walsall, this canal joins that of the Old Birmingham with the Fazeley; it joins the latter at five miles distance from the Grand Trunk near Litchfield, where the English Quintilian, the celebrated Johnson, was born.

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* For example, near the eight locks established in Birmingham; on the Digbeth branch, there is an engine, of Boulton and Watt, equal to forty-horse power.

A small navigable river leads from Litchfield down to the Grand Trunk. To the canal of Wirley and Essington numerous ramifications are attached. This canal is opened in small section; its principal object is to carry the lime and coal drawn from the quarries and mines which abound in the country through which it passes. It begins on the western side of Wolverhampton, a populous manufacturing town, the chief trade of which is the working of metals. In the environs of this place, every farmer has upon his ground one, or even several forges, under his own management, of which he takes regularly to market the manufactured articles, in the same manner as his agricultural produce. The parish of Wolverhampton, according to the census of 1821, contained 36,838 inhabitants.

The Staffordshire and Worcester Canal.

This canal, by which an active and rich traffic is carried on, belongs at the same time to the direct communications between Liverpool and Bristol, through the Trent and Mersey and the Severn; and of Birmingham with those two places, through the Old Birmingham canal.

It leaves the Grand Trunk at Haywood, passes the Trent over an aqueduct bridge, ascends, parallel with the Sow, as far as Stafford, which contains 5,736 inhabitants; afterwards it turns to the south, winding but little along the Penk—it then reaches Penkridge, a market-town; afterwards, Aldersley, its culminating point, where the Old-Birmingham Canal opens. We have ascended 100 feet by means of thirteen locks; the highest part of this canal is ten miles in length, and is fed by two reservoirs. On an extent of eleven miles and a half, we descend 166 feet, by eighteen locks, down to the mouth of the Stourbridge canal. We now travel twelve miles to reach Stourbridge, passing through two short tunnels, and finally we fall into the Severn, after a descent of 127 feet, by thirteen locks. Here are two basins surrounded by quays with large warehouses. The canal has two different entrances, one of them with small lock gates for the lesser boats employed in its navigation; the other with large gates for the river vessels.

Canal of Leominster-and-Kington.

This canal begins on the right bank of the Severn, facing Stourport and the opening of the Staffordshire and Worcester canal. It advances towards the west, into the valley of the Teme, which it traverses by an aqueduct bridge, in turning to the south, and follows this direction as far as Leominster on the Lugg. From Leominster to Kington the canal is not yet excavated—it will be forty-four miles when completed; only half this quantity is finished; it is opened in small section.

Worcester and Birmingham Canal.

This connects the two places so named. The canal leaves the basin of Newringhall, in Birmingham, and directs itself towards the south-west. It traverses a very uneven country, which has made it necessary to open four tunnels, of the following dimensions, for its passage, namely[*], at Edgbaston, 110 yards; at West Heath 2,700 yards; at Shertwood 400 yards; at Tardebig 500 yards.

These tunnels are eighteen feet and a half wide, eighteen feet high, and have seven feet two inches depth of water. From Birmingham to Tardebig, the culminating point of the canal, it has, on a distance of about fourteen miles, forty-two feet breadth at the surface, and six feet of depth of water. Great difficulties have been encountered between Tardebig and Worcester. It was necessary to descend 427 feet, on a length of fifteen miles. Some projectors deemed it sufficient to make use of inclined planes; but it was at last determined to overcome this rapid descent, in constructing narrow locks.

Worcester, the capital of the county of that name, is situated on the banks of the Severn, at the opening of the canal we have just examined; near the confluence of that river with the Teme, a river which passes by the towns of Tenbury and Ludlow. A great number of roads meet at Worcester, which, from that cause, is a place of *rendezvous* for the communications between England and the centre of Wales. But it is not merely a town of commerce and passage, several articles are manufactured within its walls, such as porcelain, gloves, distilled liquors, *&c. &c.*. By these sources of prosperity the population of Worcester shews a progress from 13,814 inhabitants in 1811, to 17,023, ten years subsequently.

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[*] At first it presents a level of sixteen miles and a half. In the last seven miles it descends 264 feet by three locks.

Droitwich Canal.

This goes from the Severn to the salt works of Droitwich, to which it carries coal, and of which it exports the produce. In the distance of five miles, this canal descends fifty-six feet and a half by eight locks. It is in large section for boats of sixty tons, and is perhaps the only canal on the globe fed from salt-water sources.

The three grand canals of Old-Birmingham, Staffordshire and Worcester, and Birmingham and Worcester, form a vast triangle, intercepted by streams and rivulets. The inhabitants wished to divide this space by a triple navigable line, communicating with the three sides of the triangle. This new line composes the canals of Dudley and Stourbridge.

The Dudley canal begins at Selby Oak, a short distance from Birmingham, and taking its direction towards the west, passes a tunnel 3776 yards long *—it runs on the same level for a length of ten miles and a half, after which it descends eighty-five feet, by nine locks, as far as the Staffordshire-and-Worcester canal. It is in small section.

A branch of the principal line of the Dudley canal rises thirty-one feet, by five locks, in the space of 1400 yards. Here we find a tunnel 2926 yards long; then by a descent of thirteen feet, which we pass by two locks, on a distance of 220 yards, we reach the Old Birmingham canal, near Tipton. Before passing the tunnel, there is, on our right hand, a branch of one mile and a quarter long, which rises sixty-four feet, by eight locks, to the town of Dudley, with another navigable branch to the Dudley collieries. This town, whence the canal takes its name, is principally enriched by the working of mines and metals. The parish in which it is situated contained, according to the last census, 18,211 inhabitants. This population presents a considerable increase from 1811 to 1821, owing to the establishment of many new founderies during the intermediate space of time.

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* There is also a second, 624 yards long, established, like this, on the principal line.

Stourbridge Canal.

This is on small section, and unites the Dudley to that of Stafford and Worcester. It commences a little north of the end of the Dudley canal, and continues to descend from its beginning.

Its total descent is 186 feet; it has twenty-eight feet in width at the surface, and five feet of depth of water. On following its course, we find, on our right, a branch which leads to Stourbridge, whence it takes its name. At Stourbridge, are extensively fabricated the same kind of articles as in Birmingham *. Independently of the working of metals, cloth, glass, and especially crystal, are made at Stourbridge. It is near the same place, in a mine, that the sand employed in making the finest crystal glass in England is found.

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* Every three months the iron merchants and manufacturers of the part of the county of which we are now speaking, have a general meeting at the markets of Stourbridge, Wolverhampton, and Birmingham.

Stratford-on-Avon Canal.

As its name indicates, it terminates at the town of Stratford-on-Avon; it leaves the canal of Birmingham and Worcester at about six miles below Birmingham; at first it runs to the eastward, in passing through a tunnel, after which it turns to the south.

Its total length is twenty-three miles and a half; namely, ten miles on a level, two miles and a half of descent, amounting to 147 feet, one mile on a level, one mile and two-thirds descending seventy-six feet; nearly six miles on a level; one mile descending eighty-six feet; and lastly, about one mile and a half on a level to Stratford. This canal has many branches which lead to the coal mines, to the lime and paving-stone quarries, *&c.* One branch, of above one mile and a half in length, connects it with the canal of Birmingham and Warwick.

From Stratford, where, thanks to the assistance of art, the Avon begins to be navigable for boats, they descend to the junction of this river with the Severn, at Tewkesbury, a town with a population of 5000 inhabitants, the principal trade of which is the manufacture of cotton stockings. Stratford is besides noted for its trade in agricultural produce; the exportation of which is made by the Avon and Severn. Lastly, by those who value the knowledge of the human heart, and the master-pieces of genius, Stratford will ever be looked upon as one of those towns which have contributed the most to England's glory, in having given birth to Shakspeare.

Warwick and Birmingham Canal.

It begins at the Fazeley and Birmingham canal, in the north of the last town, round which it goes in a north-east direction, to take its course afterwards to the south-east.

It has in length upwards of twenty-five miles—first, one mile and a half, with a descent by five locks—secondly, three miles and three-quarters, on a level—thirdly, one mile and a half, with a rise, and seven locks. Here we find the branch which joins the two canals of Warwick-and-Birmingham, and of Stratford-on-Avon—fourthly, five miles on a level—fifthly, two miles and a half, with a descent by twenty locks—sixthly, 875 yards on the same level, as far as Warwick.

The Canal of Warwick and Napton

Begins at the point where that which we have just visited terminates. It is fifteen miles in length, passes the Avon on an aqueduct bridge near Warwick, and, proceeding to Napton, ends in the Oxford canal.

Warwick is the town which gives its name to the county in which Birmingham is situated. By the census of 1821, it contained 8235 inhabitants. The increase of its population, noticed in the preceding ten years, is attributed, in the parliamentary reports, to the erection of a number of new establishments of commercial industry.

These hydraulic communications, conducted with so much success, and leading from Birmingham, deserve the more to be considered, because they are opened on one of the highest situations in England, and nearly in the centre of that vast ridge of mountains which traverse England and Scotland through their whole length. This position shews us what we may do, in the situations and valleys the most elevated in France, whenever we shall think of creating centres of industry and commerce, and of connecting them with the principal *basins* where our agricultural riches display their magnificence. But every where, as in the environs of Birmingham, we must be contented with canals of small dimensions, which consume little water, yet suffice for the most active traffic, and produce immense revenues.

Hydraulic Communications of Bristol.

In describing the coasts and ports, we shall give on Bristol all the details which the importance of that commercial place can claim. We have already explained its connexions with London, Birmingham, and Liverpool; it remains to speak of some other lines, of which it is the centre.

A project has been formed to open hydraulic communications between the sea, or the Bristol Channel, and the southern coast of England. The first navigable line, mentioned Chap. iv. would pass at Bath and Bradford, on the canal of the Kennet and Avon; afterwards, a canal would be conducted by Frome to the Stour, which runs into the sea at

Christchurch near the Isle of Wight. The second navigable line would be directed from Bristol to Bridgewater, parallel with the left bank of the Severn, and afterwards, to Taunton. At Wellington, it would join the canal, already executed, from that town to Tiverton. Before reaching Tiverton it would reach on the left, the Grand Western Canal, which would terminate in the bay of the Exe, below Exeter.

On going from Bristol to the sea, by the Avon, on the opposite side, and in front, is the Welch coast, on which several canals and rail-roads descend directly. These various communications are connected immediately with the coasting trade of Great Britain, and belong to the description of the sea coast. *See* Vol. II.

Hydraulic Communications of Hull.

In the preceding chapters, we have shewn how to proceed to this town, through the navigable inland lines, from the great ports of London, Liverpool, and Bristol; we have consequently already explained the most important lines. It remains to give details on the other lines.

Kingston-upon-Hull, denominated Hull, for abbreviation's sake, is built upon the river of that name, navigable for a distance of twelve miles, and prolonged about eleven miles and a half to Driffield, by means of a lateral canal. Driffield, a town possessing many woollen and cotton manufactories, has an extensive corn market, supplied by the neighbouring country. On the left bank of the Hull begins the canal of the Hull and Leven, only about three miles in length.

Near the mouth of this river, in the vast bay of the Humber, if we advance towards the bottom of the bay, on the northern shore, we meet the canal of Market Weighton, which leads to the town of that name. A lock-gate, communicating with the sea, at its entrance,—three common locks near the town,—and the rest on the same level for a length of eleven miles and a quarter, in following a direction from south to north; such are the details of this canal, which is in small section—like that of Driffield, it is the work of Smeaton. It joins the bay opposite the mouth of the Trent, of which river it seems to be an artificial prolongation.

The Ouse, which falls into the bay of the Humber, between that canal and the Trent, perpendicularly to their common direction, receives the waters of a number of navigable rivers.

In ascending this river, we meet, on the right, first, the mouth of the Derwent, which is navigable on a distance of thirty-five miles to New Malton—secondly, the Foss*, which falls into the Ouse, a little below the city of York, so remarkable for its magnificent cathedral, one of the grandest and finest monuments of Gothic architecture. York, traversed by the Ouse, and by the principal roads of the extensive county of which it is itself the capital, as well as by the great road from London to Edinburgh, is placed in a position most advantageous for commerce. Its population, according to the last census, amounted to 38,731 inhabitants.

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* In its higher part it is rendered navigable by lateral cuts, to avoid shallows and long windings. The navigable length is thirteen miles.

Beyond York, the Ouse continues to be navigable without the aid of art as far as Aldborough, built at the confluence of that river and the Swale, Higher up, commences a canal lateral with the Ouse; it goes as far as Ripon, the end of the navigation: this work was performed by the celebrated Smeaton. Above Ripon, the Ouse takes the name of the Ure.

In descending the right bank of the river, which we have just surveyed, we find below York, the mouth of the Wharfe, the course of which is easterly, and navigable from the town of Tadcaster. Still lower down, is the town and short canal of Selby, which joins the Ouse and Air at some distance from their confluence. From this place to Leeds the Air may be navigated. We may then follow the canal, which, in the north, leads to Liverpool, as we have seen in Chap. ii. We may, besides, before arriving at Leeds, enter the Calder, and ascend, at first, to Wakefield, a town known to the French only by a tale of Goldsmith's, full of beauty and truth; but it is mentioned here merely as a manufacturing place, commercial, rich, and populous. The fabrication and dyeing of woollen cloths, are its principal manufactures, in which it competes with Leeds. The elegance and size of the edifice erected for the sale of clothes must not be passed by unnoticed. Round Wakefield, numerous collieries are worked, the products of which are conveyed by tram-roads to the Calder. The parish of Wakefield contains 22,307 inhabitants, and the town 10,764, according to the census of 1821.

Works and lateral cuts render the Calder navigable as far as the town of Halifax, where we re-join the hydraulic communications of Manchester. These may also be re-joined by the Ramsden canal, which opens on the right bank of the Calder. (See Chap. ii.)

On the same bank, a little below Wakefield, the canal of Barnsley begins, which takes a southern direction, in a distance of a little more than eleven miles as far as that town. It proceeds afterwards four miles to the north-west. Barnsley, a manufacturing town, is surrounded with forges and collieries, and they fabricate there principally metallic wires and common cloths. Its prosperity is so great, that from 1811 to 1821, the population increased from 5014 to 8284 inhabitants.

A second canal contributes to this prosperity; it is the Dearn and Dove*. Beginning at Barnsley, it gains the valley of the Dearn, up which it proceeds, by a branch, to Rockley, and descends to the Dove, a river which passes by Rotheram, a town on the banks of the Rother. Rotheram is known for its iron and steel-works.

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* It is, as the last, opened in large section. Its locks are seventy

At the confluence of the Don and Sheaf, a little below Rotheram, is the town of Sheffield, more famous still for its cutlery, iron-ware, button-making, and works in metal generally. Fifty thousand persons are occupied in these manufactures, on a soil rich in iron and coal-mines. In Sheffield, one single Lancasterian school is sufficient for the instruction of 800 children! It possesses several others, and also Sunday and Charity-schools, *&c.* Thus, in England, the instruction of the people everywhere flourishes with industry and commerce. The town of Sheffield itself contains 42,157 inhabitants; but the whole parish, so remarkable as we see for its industry, contains a population amounting to 62,105.

On descending the Don, below Rotheram, on the right bank of that river, is the town of Doncaster. Its inhabitants are principally engaged in the spinning and weaving of wool and cotton. In 1821, its population amounted to 8544. The Don, in its navigable part, descends seventy feet by eighteen locks, having from sixty-three to seventy-two feet in length, and from fifteen to eighteen feet in breadth, for boats fifty-six feet long, and fifteen feet wide.

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feet long, fifteen feet six inches wide, for boats of fifty tons from Barnsley, the point of departure; it is nine miles and a half long, and rises 119 feet. John Thompson was the engineer.

Below Doncaster, near Thorne, begins the canal of Keadby, which proceeds on one level from the right bank of the Don, to the left bank of the Trent, over a distance of fifteen miles. It has a flood-lock at each extremity. Its object is less that of a commercial navigation, than the draining of the flat country in the vicinity of the Ouse, in which the Don discharges itself. This canal crosses a river called the Old Don, which falls into the Trent a little below Burton, a town with 4114 inhabitants. We have described the course of the Trent in Chap. iii. and iv. of this work. On proceeding from this river into the bay of the Humber, to trace the southern side of the bay, we pass before the canal of Ancholme, which is directed to the south, and ascends, by a branch, as far as Caistor, a market-town of the county of Lincoln.

From this rapid survey, it will be seen that the port of Hull is at the confluence of a number of hydraulic ways, which bring to the sea the natural productions of a large space of country, and also the manufactured articles of a considerable number of towns. This position explains the prosperity of that fine commercial port; a prosperity of which a view will be given in the volume set apart for describing the coasts and ports.

CHAPTER VI.

General Recapitulation of the Fourth Book.

We have now laid before the reader, at one view, the most extensive system of inland navigation that any people ever established upon an equal superfices. We have followed each line of canal, between the seas which surround England, east, west, and south. We have seen the hydraulic ways of this island grouped about six great central points, Manchester, Liverpool, London, Birmingham, Hull, and Bristol, and so arranged, and offering communications so numerous and so well combined, that each of these rich towns partakes of the acquired opulence and of the industry developed in the other five, and in the fine country which separates them; whilst the produce, imported or manufactured in these places, is spread abroad by the same communications, so as to reach, with economy and rapidity, the innumerable points of consumption. In running over thus on every side, and setting out every where from the principal focus, the richest part of Great Britain, we have carefully pointed out the towns most remarkable for business, or some peculiar branch of industry, and the fertile districts which devote to trade their agricultural produce, and that of their mines and manufactories.

The fact, which at first view strikes the mind, is the narrowness of the territory where the works of communication have produced the most astonishing results; and this fact in itself will lead to a most important conclusion respecting our own country. The part of England so intersected with canals, is, as we have before observed, less in extent than a square having 180 miles on each side, and this square very little surpasses in extent one-seventh part of the whole superficies of France. If, then, on the total superficies of France, we could find only a sixth portion already favoured by nature, with abundant and widely-extending streams, with the fertility of the soil, with mineral resources, or, at least, with easy communications to iron and coal-mines, we might be able, with this one-sixth of our soil, and by works similar to those we have been describing, to equal the prodigies produced, within the space of a few years, in that part of Great Britain which constitutes her riches and power.

But we have three-sixths instead of one, which seem destined expressly by nature, to enable us to vie with the happy state of England. The *basins* of the Loire, the Seine, and the Somme, may be united by a number of hydraulic ways, either with each other or with French Flanders, already completely canalized. Let us open a canal parallel to the Seine, from Paris to Rouen, and other parallel canals in the upper parts of the rivers which form the three *basins* we have mentioned.—Let us establish communications with the principal lines of navigation, either by secondary canals or rail-roads, to all our larger manufactories and important quarries.—Let us examine the soil of this part of our country, and seek, at the depth of 550 yards, and even deeper if necessary, if it contain not mines, especially coal and iron; and, if our researches are crowned with success, let us convey in our towns and sea-ports, by means of canals or iron rail-ways, the produce of those mines. Were this portion of our country thus animated by new and abundant means of circulation, how many large towns would then contribute to the prosperity of industry and commerce! In the *basin* of the Loire, St. Etienne, Clermont, Roanne, Moulins, Nevers, Bourges, Orléans, Tours, Poitiers, Mans, Laval, Rennes, and Nantes; in the *basins* of the Seine and the Somme, Auxerre, Troyes, Châlons, Sens, Montereau, Meaux, Saint Quentin, Compiègne, Amiens, Abbeville, Caen, Dieppe, Rouen and Hâvre; and finally, the rich and populous towns of French Flanders, and of the Pas-de-Calais.

But at the same time that the canalization of this part of the territory of France would be effected vigorously, we should not neglect the other provinces who would derive such great benefits from it. Three other groups of lines of communication might be completed; the first, in the *basins* of the

Moselle, the Meuse, and the Rhine; the second in the *basin* of the Rhône; the third in the *basin* of the Garonne. By the first, our commercial power would extend its action, beneficial to ourselves and our neighbours, among all the people of Germany; by the second, over Italy and the vast shores of the Mediterranean; by the third, over Spain, Portugal, and the British Islands.

The government has published a work of great interest on the canals which it is intended to open throughout France; this plan is on a scale of great magnitude, which no doubt has its utility, but which is not suited to the actual state of our industry and commerce. Supposing that the government alone could complete the construction of these canals, with a sufficient degree of promptitude, and without making too great sacrifices, the result will only be the frame-work, on which numerous and indispensable ramifications must be attached, to open a communication with the focus of industry, which each of our secondary towns, our rich mines, and our large isolated manufactories may present; and the enterprise of these will be greatly to the interest of our landholders, manufacturers, and merchants. We only repeat a thing, said for the tenth time, in recommending strongly to them, and for their own advantage, to form companies in order to establish means of conveyance for their commercial produce, either by common roads, canals, or rail-ways. They will find, in the descriptions that we have laid before them, on the general system of communication in England, models adapted to every kind of locality. The communications, of which Liverpool and Hull are the centre, will serve as an example for a flat country. Those, of which Birmingham is the central point, will serve, on the contrary, as an example for higher parts. The roads and canals which traverse the great chain of mountains, running from north to south, through England, afford numerous and important models, to pass from one *basin* into another. We shall learn not to shrink from difficult sites, in seeing by what works of art the English have effected such passages—tunnels 5500 yards in length, large excavations, extensive causeways, and raised embankments, as at the canal of Ellesmere, inclined planes of great length, and locks, the multiplicity of which is astonishing, even compared with those of our most celebrated canals. The reader will be able to form an idea of all this from the following statements:—

France.	Length.	Number of Locks.
Canal du Midi . . .	148 miles . . .	62
Canal de St. Quentin .	80 . . .	37
Total . . .	228 . . .	99

England.	Length.	Number of Locks.
Rochdale	21 miles . . .	49
Worcester	5 . . .	71
Total	26 . . .	120

	Length.	Locks.
Grand Junction	90 miles	101
Grand Trunk or Trent and Mersey	93	75
Leeds and Liverpool	130	90
Total	313	266

These locks, in themselves, as well as many other works, have nothing superior in their construction to those for which we are indebted to our able engineers of roads and bridges. These works, indeed, are frequently executed in a very inferior manner, sometimes from negligence, often from ignorance, but more generally from a motive of economy; this latter cause deserves our greatest attention. The canal companies of England have principally their interest for an object; they do not endeavour to display a vain luxury in their constructions; it is in their revenues they seek for glory and opulence, and these are the wise ideas it behoves us to acquire.

Nevertheless, we have mentioned magnificent works of art, executed by companies, when they have judged them necessary. They show the greatness of private resources, and suffice to convince us that there is no sacrifice, or difficulties, which a well-directed association cannot make or conquer.

As human passions too often interfere with the wisest conceptions, companies sometimes have been led into foolish expenses, in projects which had dazzled them; and, suffering themselves to be actuated by a puerile feeling of vanity, they have endeavoured to outvie rival companies in the sumptuousness of their works; but they have found, in their ruin, the chastisement of their folly and ignorance. This ruin, however, though unfortunate for the public welfare, has not been without its compensations—it has served for a lesson to make speculators and capitalists more prudent. Unhappily for us, if similar faults should happen to be committed by the administration and engineers of government, in works executed on account of the state, these errors would not produce equally happy compensations. The public treasury is most commonly ignorant of the profusion that exhausts it; it is an immense fountain, running without ceasing into so many channels, that nobody could assert that it empties itself too rapidly, because it runs more copiously into this channel than into that. This renders it desirable that government should be at the expense of those works only which are evidently beyond the power of private associations; and even in this case it would be preferable that government should merely advance or even give the sum necessary to complete the whole demand with the portion provided by private industry, on condition that private individuals should execute, on their own account, as for their own interest, the works projected for the sake of public utility.

Among the works of art that the English canals offer for our imitation, we will remark the double locks—as, for example, that of the Regent's Canal;

the safety-gates to retain the water, in case of the breaking of the causeways or embankments; the employment of iron in some parts of the constructions, above all in the lock-gates, and for aqueduct bridges, as at Llanydoc and Pont-y-Cyssylte. But it must not be thought that the substitution of iron for brick, stone, or wood, will produce the same advantages in France as in England. It is sufficient to ascertain this, to propose a simple arithmetical question—what are, for each locality, the comparative prices of iron, wood, brick, and stone,—the duration and expenses in repairs of works constructed with each species of materials; in fine, what is the capital required for the execution of works of art with these materials? The best system will be that which demands the most moderate capital; iron being so much dearer in France than in England, its use cannot have the same advantages, and therefore cannot be so frequent; but the use of iron will become less and less rare among us in proportion as we shall simplify its fabrication.

Analogous observations must be made on the consumption of fuel, in feeding canals by means of steam-engines; coal is much more expensive in France than in England; we should find it, therefore, a bad economy to have recourse to the mode of supply which the English often adopt with great advantage, particularly in the environs of Birmingham, in a high country, where water is as scarce as coal is abundant. If the means we allude to could be favourably applied here, it would be in such places as St. Etienne, situated in a high country, like Birmingham, and producing fossil-coal at an equally low price.

The inclined planes, with iron tram-ways, the small boats which they require, and the numerous locks, which serve for the passage of the boats, offer us examples, which it will be, in many cases, advantageous to imitate. We shall speak of them in detail, in treating of the mode of carrying goods.

We shall finish with an observation, which will shew how far economy, in associations for public works, conduces to important results. At the present time the direct communication between London and Liverpool can be effected by the small navigation only; it is the same thing, with regard to London and Birmingham, Hull and Manchester, Birmingham and Bristol. Thus, the small navigation has been sufficient to ensure the prosperity of the inland commerce, between the most industrious towns and the most opulent ports—consequently, with a small navigation, well combined, in the interior of France, we should be able to attain the same degree of prosperity.

We may have, in some well-frequented places, canals formed on large dimensions; but we must be very careful not to extend too far this expensive system, which not only swallows up treasures, but occasions too great a consumption of water, a thing of which it becomes us to be more sparing than the English, since nature has not afforded it us in so great an abundance.

In adopting, in all the establishments which concur to national prosperity, the course which we have pointed out, we shall but seldom, it is true, offer to the panegyrist the wished-for opportunity of giving pompous descriptions of works displaying an ostentatious magnificence and ridiculous vanity; they will not have to perform the task of celebrating the men of ruinous memory to whom these immortal extravagances owe their existence. But the voice of history will have great results to offer to the admiration of posterity, in describing a vast system of useful works, executed by the hands of wisdom, bearing the appearance of modest simplicity, and formed according to the plans dictated by prudence. Instead of burying our wealth under the sterile luxury of shewy edifices, we will plant, we will sow it, if I may be allowed the expression, among a multitude of fertile furrows, humble, I grant, in their appearance, but admirable as to their well-combined *ensemble*, and the happy fruits they will produce. We may then do that, which Great Britain is now doing—astonish the universe with the abundance and beauty of the produce which will be exported from our soil, to be conveyed and exchanged on every point of the commercial world; and finally, France will be reckoned among the centres of industry, the energetic influence of which manifests itself by the greatest advantages in every part of the globe.

BOOK V.

THE LEGISLATION AND CONSTRUCTION OF BRIDGES.

CHAPTER I.

Legislation of Bridges.

There are, in England, bridges which are private property; others belonging to political bodies, such as corporations and private associations. All are kept in order, and repaired at the expense of their respective proprietors.

An act of parliament, promulgated in the 22d year of the reign of Henry VIII., chap. 5, regulates every thing that concerns the keeping up and repairs of bridges and their approaches. By this act, all things concerning these works, as far as they are connected with the freedom and safety of the highways, are to be laid before the sessions of the justices of the peace, who are to decide. The justices of the peace may compel all persons injuring a bridge to put it in repair. Where the perpetrators are not known, or when accidents occur from natural causes to a bridge, being a thoroughfare, and without a toll, the repair is effected at the expense of the inhabitants of the county in which it is situated. If the bridge comes within the limit of authority of two different justices of the peace, the inhabitants of each township must restore that portion which comes within their own territory. The justices, with the corporation, or two persons appointed from each parish, regulate accordingly the sum to be paid by the citizens. The justices name, first, two persons to collect the rates in each district; secondly, two surveyors to direct the works and apply the funds remitted for that purpose by the collectors. These four officers, having a salary fixed at the discretion of the justices, are accountable to them for the management and employ of the money. The law gives to the justices the means of enforcing the execution of these different regulations. The same authority extends to the repairs of the public road near the bridges, within 100 yards' distance,

As we see, by the considerations of the statute 1, of Queen Anne, chap. 18, a long experience had demonstrated that these measures were as embarrassing as onorous for the inhabitants. They permitted the exaction of more taxes than were needed for the reparation of bridges; taxes which were often applied differently from their original destination. By this same act, the contribution must be levied by the constables of each parish, and paid into the hands of the high constable of the hundred, who remits it to the treasurer nominated by the justices of the peace. Every municipal officer who neglects to rate the inhabitants proportionally, to levy the tax accordingly, and to deliver it to the proper person, may be fined 40*s.* Every treasurer who pays any sum whatever for the repair of bridges, without an order from the justices, is liable to a fine of 5*l.* Every fine, by virtue of the same act, is vested in the funds for the repair of bridges and their approaches, and does no longer go into those of the exchequer.

It now remains to notice bridges undertaken by companies: the legislative measures appended to them are identified, in a great measure, with those which are arranged for the formation of canals.

Thus, with regard to bridges, as to canals, the grantees form a political body, which is the holder of the funds destined for the work. They are divided into shares which amount generally to 100*l.* The same analogous precautions and formalities regulate the calling in of the funds, loans, mortgages, re-imbursement of creditors, arbitration and payment of the ground and edifices that the company are obliged to purchase, *&c.* At a general meeting, and by a determined majority on a fixed number of shareholders, the various resolutions essential to the proceedings of the company are taken, modified, or revoked, the operations of the agents are examined, and the accounts passed, *&c.* A directing committee appointed by a general meeting of the shareholders, conducts the technical part of the work and keeps the accounts. This committee prosecutes legally the authors of every damage or injury sustained by the property of the company. Engineers, a treasurer, a secretary, clerks, collectors, are the agents of this executive power, and are required to give security.

Let us now examine what is peculiar to the legislation of bridges. The act or grant comprehends the general estimate of the work, and the order which must be followed in its execution. The number of arches, their dimensions, those of the piers and abutments, the width of the road in the approaches of the bridge, and on the foot-paths, flight of steps, towing-paths, *&c.*, nothing is omitted.

If, during the construction of the work, it is possible to leave a part of the river open for navigation, the act of parliament binds the company to keep it so, and subjects it to pay a sum of money, proportionate to the loss which commerce may sustain, in case the navigation should be interrupted. Thus, with regard to the Southwark bridge, composed of three arches, the act forbids that the centring of more than two should be up at one time, in order to leave a free space in the third arch, under the penalty of having the centrings demolished *ex officio*, and laying a fine upon the company.

The magistrates are empowered to take more severe measures to enforce the prompt construction of bridges than of canals. When a new canal is undertaken, the only inconvenience which arises from the slowness of the work is, that the company is kept the longer from enjoying its benefits. But every delay in the erection or repair of a bridge, obstructs, at the same time, the roads in the direction of which it is situated, and the navigation of the stream over which it is thrown. For this reason, the legislature never permits the construction of a bridge to commence, until the shareholders, possessed of a capital sufficient to present a satisfactory guarantee, have placed in the public funds a part of this sum, there to remain and accumulate with the interest which such an investment must produce. A certain number of persons are designated in the act as trustees or guardians of these funds, which must remain untouched, until they decide that there is a sufficient accumulation of capital to meet the expenses of the work. These guardians or trustees are also appointed to take care that the works are finished within the space of time fixed by the act.

Two important objects to determine, are the regulation of the police on the bridge, and the receiving of the tolls.

The police of the bridge belongs to the company who have undertaken it. If it is situated in a town, the company is authorized to establish patrols and watchmen upon it, and to light it with oil or gas. If any one break the lamps or extinguish the lights, he must pay a fine, which increases for every offence*, and in case the perpetrator is insolvent, he may be imprisoned or sent to hard labour.

With regard to bridges, as well as to the roads and streets, the legislature leaves to the public in general, the care of seeing that the public thoroughfare may not be obstructed. If a bridge-company or the managing committee be negligent in any respect, should not keep it in repair or proper order, well lighted, *&c.*, every citizen has a right to inform against them. When the informer proves his accusation to be just, he receives a considerable sum, which the company is obliged to pay him. The same fine must be paid for every contravention of the act, which shall be judicially proved.

We will now direct our attention to the tolls which form the revenue of the company. If the grant be perpetual, the constant revenue serves to pay the running expenses for the repairs and guarding of the bridge; the remainder being proportionally divided among the shareholders. If the grant be only temporary, (which seems the most advantageous mode in this species of public works, and that which we propose should be adopted in our own country,) the act of parliament contains provisions which ensure to the company the reimbursement of its advances, a good interest for its capital, and the investment of a fund for the repairs of the bridge, the dividends of which must be sufficient to pay, first, the annual repairs, and secondly, the lighting and watching. In order to give to our readers correct ideas upon this subject, by a remarkable example, we will mention the provisions of the act made for Southwark bridge in London.

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* At the Southwark bridge, an offender pays for the first offence 10*s.* per lamp; for the second, 20*s.*; for the third, 40*s.*; and for the fourth, 40*s.*; and, is, besides, sent to prison.

Tolls. Carriages and horses: with six horses, 1*s.* 6*d.*; four horses, 1*s.*; two horses, 9*d.*; one horse, 4*d.*; heavy wagons, six horses, 1*s.*; four horses, 8*d.*; two horses, 4*d.*; one horse, 3*d.* A saddle or pack-saddle horse, 1½*d.*; foot-passengers, 1*d.*; cattle, 4*d.* for every ten head; flocks, 4*d.* every twenty head. The carriages and animals passing again the bridge on the same day, do not pay a second time. Soldiers and military equipages, mail-coaches and horses, bearing the mail, pay nothing. During the times of election, beginning at the eve of the first day, every elector is free to pass without paying toll, with his horse or carriage.

The current expenses of management, and the interest of the company's loans being first provided for, the following is the mode of distribution of the revenue:—first, among the shareholders, at least five, and not more than ten per cent. on the shares subscribed and paid by the company; this interest to begin from the moment the bridge is open to the public. Secondly, if the tolls produce more than will pay a dividend of ten per cent., the surplus is vested in the public funds, (three per cent. consols.) This investment, with the compound interest, constitutes a capital which is left to accumulate until it produces an annual revenue equal to the interest of ten per cent. on the sum total subscribed. Then this capital is divided between the shareholders, proportionally to their respective shares. From that time, they no longer receive any dividend; the whole amount of the tolls received, is placed in the public funds, to form a new capital for paying off any loans or charges which may still hang on the property of the bridge. Finally, the whole revenue of the tolls continues to accumulate until it yields an annual interest equal to the largest sum necessary for repairs, watching, and lighting. After this, no more tolls are to be received, and the bridge becomes a public and free property. If, before the reimbursements, the paying off the debt and the funding before-mentioned, can be complete, some important repairs of the bridge should consume more than the annual produce of the tolls, the excess would be taken from the funds already accumulated.

Here, let us remark the following clause which deserves to be adopted in our legislation for the construction of public works. When the tolls will no longer be levied, the shareholders and their heirs will nevertheless continue to constitute a company, intrusted with the management, preservation, repairs, paving, lighting, and cleanliness of the bridge, by means of a directing committee, subordinate to the general meetings of the shareholders. These, when all the current expenses are paid, from the interest of the capital lodged in the public funds, will have a right to divide among themselves, as a dividend, the remainder of the annual interest.

CHAPTER II.

Stone Bridges.

The territory of England and Scotland is too circumscribed to allow the formation of a great number of very large rivers. Thus, in both kingdoms, the bridges are more remarkable for their structure and number than for their dimensions. Nevertheless, on approaching the mouth of some rivers, such as the Severn, the Wear, *&c.*, monuments of this kind may be found well worthy the attention of professional men, for their magnitude, not less than for the beauty of their construction.

The bridges of the metropolis are above all worthy of study. Thrown over a very large and deep river, subject to the great variations of the tides, these bridges seem to unite in their execution, all the difficulties which nature could offer to the efforts of the genius of men. These difficulties, at first imperfectly surmounted, have yielded to the progressive efforts of art and experience. Our own works have offered, in this respect, many models which the engineers of Great Britain have had the wisdom to imitate.

London Bridge, built in the twelfth century, is the most ancient and most defective of all those of the capital*. The arches are narrow, unequal in span, and rest upon masses of an enormous size, which produce, at the rising or falling of the tide, a very dangerous fall. In 1756, the houses which had been built on this bridge, being in a ruinous state, were pulled down. It is about to be rebuilt, and every thing leads us to think that parliament will adopt the plans of the late Mr. Rennie, and that the execution will be confided to his son. †

During more than six centuries, London bridge was the only communication on the banks of the Thames, between the capital and the suburb, situated on the south side, (Southwark).

Between the years 1738 and 1750, Westminster bridge was erected.

This bridge is 410 yards, two feet, in length, and forty-four feet wide. It cost 389,500*l.* sterling. It has thirteen large and two small arches. On each side of the centre arch, which is seventy-two feet in span, the others decrease in size successively by five feet.

Westminster bridge, instead of the shops which are seen on the Pont-neuf, has over each pier a semicircular niche, covered with a half dome, with seats round the inside; then, a very high balustrade runs from one pier to the other. Travellers have seriously asserted, that this balustrade, almost inaccessible, was built with a view to restrain the English attacked with that malady which leads them to self-destruction, either to escape the burden of existence, or to flee from the pangs of remorse.

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* It is 305 yards long, by forty-five feet wide. It has nineteen arches; one in the centre is more than sixty-nine feet wide.

† The execution of this great work is now in a very forward state; 1825.

Blackfriars bridge, erected between 1760 and 1769, nearly divides, into two equal parts, the vast *basin* of the Thames, between London and Westminster bridges. It is decorated with columns of the Ionic order, placed in pairs at the head of every pier. Like the last bridge, it is built of Portland stone. It is but 366 yards, two feet, long. The centre arch is 100 feet in span; the two contiguous arches, right and left, are ninety-three feet, one inch, the others decrease in the same proportion.

The Strand bridge, begun in 1811, is about half-way between Blackfriars and Westminster. Since 1816, the English have named it Waterloo bridge, in imitation of the French, who, in the days of their triumphs, named the streets and bridges with which they embellished their capital, Austerlitz, Jena, Wagram, Rivoli, Marengo, Frejus, Fontenoy, *&c. &c.*

The Strand bridge is 413 yards in length, which exceeds the length of all the other bridges on the Thames. On the side of London, the axis of the edifice is prolonged by a large avenue which reaches the Strand, a street parallel to the Thames, and so much the more important, as that fine river is nearly everywhere without quays. This prolongation is supported on a length of 132 yards, by sixteen lofty brick arches. On the Southwark side, the same axis is prolonged by a causeway which terminates at Stamford-street; it is 416 yards in length, and is supported by forty arcades built of brick. Thus, the total length of public road, supported by arches thrown over the Thames and by the collateral brick arches, is consequently 961 yards—above half a mile. A high and fine balustrade serves as a parapet. Above each pier, a projection, of a square form, surrounded with seats, forms a balcony. It is from that spot that one must take a view of the Thames, the shores of which present a most magnificent spectacle.

According to the method introduced and practised with great success by the French engineers, this bridge is on the same level from one end to the other, and the arches have all the same size*.

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* Nine arches of equal size, having each 120 feet span, are carried upon piers twenty feet in breadth at the surface of the water, and thirty feet at the base. This base rests on 320 piles, each being about one foot in diameter, and eighteen or twenty-one feet in length, (there is one pile to three feet square;) consequently the waterway under the Strand bridge is 360 yards. The width of the bridge is proportional to its other dimensions. The carriage-way is twenty-eight feet wide. The foot-paths are seven feet wide, and are covered with slabs of granite, the slabs being in length the same as the width of the path.

Their figure is borrowed from the bridge of Neuilly. This disposition is simple and majestic, but it should be obtained without raising too high the line of the road that passes over the bridge. The celebrated engineer who built the Strand bridge may be censured on this point. The excessive height of the bridge, crushes, in part, the fine façade of Somerset-house, which looks on the side of the river. The cornice of the portico which forms the base of that edifice, instead of uniting with the cornice of the bridge, is strikingly lower; the effect which results from this is contrary to good taste.

On standing in the middle of the Strand, in the centre of the street that leads to the bridge, instead of having a commanding view of that fine road, and of the parapets which crown the bridge, nothing is discovered but the two nearer toll houses; the rest, placed on an horizontal plane, too elevated for the spectator, escapes to his view. If, as it has been projected, the street leading from the Strand to the bridge should be prolonged, this street, having a rapid ascent, would offer the most favourable spot, from which one might have a full prospect of, and admire, the upper part of this edifice, and the continuation of the causeway to the very centre of Southwark.

When looking at the Strand-bridge, either from the Westminster, or the Blackfriars bridges, the defects of which we have spoken cannot be perceived, and the only thing which strikes us is its regularity and imposing grandeur. We then pay little attention to those coupled columns which the architect has placed at the upper and lower head of the piers, to sustain the entablature, which itself seems to be placed there only to be supported by the columns*.

All the accessories of architecture, considered as the patrimony of good taste, are oftentimes well placed in a small edifice, where there is no other means to shine but by the graces of their detail—but in vast monuments the vain delusion of ornament vanishes, and the only thing which strikes the mind of the spectator is the magnitude of the whole, and the harmony of the principal masses. I appeal, for the truth of this, to those who have seen the edifices of Greece, Italy, and Egypt, and whom nature has endowed with a high taste, and a mind capable of feeling the masculine beauty, which is the true character of those masterpieces of a simple but grand architecture.

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* In reply to this objection, it may be said that Blackfriars bridge has similar columns, and the engineer of the Strand bridge has been content to follow, in this respect, the example of his predecessor; but in the bridge of Blackfriars, the arches being less at the extremities than in the middle, the columns in front of the piers grow smaller and smaller on proceeding from the middle of the bridge towards either shore, which produces a most detestable effect. On the contrary, the columns of the Strand bridge are equal in size, and gain by their general harmony what the others lose by their disparity. Lastly, these columns sustain the balconies mentioned before as placed on each pier, and it cannot be strictly said that they are useless. Yet I believe that a buttress, flat or circular, rising above the pier to sustain the balcony, would have been more becoming than massy Doric pillars. I ground my judgment in this respect on what the architects and engineers have done in this respect in the finest bridges of France. The bridge of Louis XVI. has columns, that of Neuilly is without them; they are two masterpieces, by the same hand, but the latter is much preferred to the first.

The structure of the bridge we are describing is managed with great skill, the result of profound experience*. The piers, the arches, and abutments are of Cornish granite; the balustrades and parapets are of granite, from Aberdeen, in Scotland, the grain of which is finer and whiter than that of the former. The courses of the piers and the arches are composed of very large blocks, which gives to the whole the appearance of the most imposing building of the Romans.

On looking upon ancient monuments, there is a sort of pleasure arising from our admiration, when, in our minds, we measure the large dimensions of the stones or marbles with which they are composed.

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* In order to diminish the weight on the piers, vacant spaces have been left over each, which terminate in a right line under the road of the bridge—walls of brick, parallel to the bridge's length, are erected at equal distances, in these interior spaces, and covered by slabs of stone, which support the earth and the gravel which form the bed of the carriage road.

In order to bind more closely the stones of the arches with the courses of the piers, care was taken, on placing every block, to ram it down against the parts already in their place; by this means, when the centring on which the arches were built was taken away, their middle point sunk in no part more than one inch and a half.

We delight in representing to ourselves a race of men endowed with uncommon patience and vigour, shaping with minute precision these gigantic elements, and transporting them, by the power of their strength, or industry, from the bottom of the quarry to the summit of the edifice thus formed by their re-union. It is the fable of the Titans, illustrated by man struggling with nature.

When I have visited the works of the Romans in Languedoc, I have examined the bridge built within a few years, against the ancient aqueduct of Gard. The modern work has the freshness and polish of a recently-finished edifice; seen alone, it might appear imposing and almost majestic, but as it is constructed with stones of a small size, it seems as if it were crushed by the enormous masses which the Romans laid one upon another, two thousand years ago, and which time has been unable to overthrow.

In the Strand bridge, the interior of the piers and arches, as well as the *extrados* of the arches, are composed of stones less voluminous, and not so durable as those used in the outside; but not being exposed to the corrosive action of the air, they will always preserve their strength and solidity. On the contrary, the other bridges of the capital, those of Westminster and Blackfriars, and, above all, that of London, are built of a soft stone, liable to crumble by the action of the air; they have already suffered prodigiously by the ravages of time.

If, from the incalculable effect of the revolutions to which empires are subject, the people of the earth should one day inquire, "Which was formerly the *New Phœnicia*, and the *Western Tyre*, which covered the ocean with her vessels?" the greater part of her edifices, consumed by a destructive climate, will no longer stand to answer with the dumb language of monuments; but the Strand bridge will ever exist to repeat to the most remote generations "Here stood a rich, industrious, and powerful city." The traveller, at this sight, will imagine that some great prince sought to signalize the end of his reign by many years of labour, and to immortalize the glory of his actions by this imposing structure. But if tradition tell him, that six years sufficed to begin and complete the work—if he learn that a mere company of merchants built this mass, worthy of Sesostris and the Cesars—he will the more admire the nation where similar enterprises could be the fruit of the efforts of a few merchants and private individuals. And, if he should then reflect on the causes of the prosperity of empires, he will understand that such a nation must have possessed wise laws, powerful institutions, and a well-protected liberty; for these are stamped in the grandeur and utility of the works completed by her citizens.

CHAPTER III.

Iron Bridges.

THESE are very numerous in Great Britain. It was in England, and in the year 1779, that the first bridge of this kind was constructed at Colebrookdale, on the Severn. In 1796 the Sunderland bridge was executed, much bolder in its form and dimensions than the preceding—both are of one arch; the first is semicircular, the second very flat. The plates will suffice to give the reader a correct idea of their construction. We shall give, besides, minute details of the Sunderland bridge, which we have carefully examined—we have given likewise the design of the iron bridge of Vauxhall, in the west of the metropolis, the most remarkable of all before the erection of that which we are about to describe.

The *Southwark Bridge*, built to join Southwark with the city of London, is the mark of a new epoch in this kind of construction—it is one of the works which do most credit to Mr. Rennie, who was the architect. A thing which gives it a character of originality well worthy our notice, is the employment of cast-iron, in large plates, made in the usual shape of *voussoirs*, and giving a great solidity by their resistance to the pressure, that is to say, in the most advantageous manner, according to the nature of cast-iron. In fact, in the construction of all the other iron bridges open ribs were used, which no doubt gave a great lightness to the system, but could not unite the same degree of strength and durability.

This bridge has only three arches. The span of the middle arch is 240 feet; that of the two lateral arches is 213 feet; the width of the piers is twenty-four feet; the total length of the bridge is 236 yards, of which 222 yards are allowed for the water-way.

Although the Southwark bridge is not more than half the length of that of the Strand, it presented nevertheless, greater difficulties in the execution; first, for that very reason that it is not so long by half as the Strand bridge, the stream, whether the tide rises or falls, is much more rapid under its arches than under those of the latter—the depth of the water is greater in the ratio of thirteen to eight*, and the piers have consequently a greater power to sustain from the water: moreover, the arches having less elevation and a wider span (the middle arch is just double the arches of the Strand bridge), their pressure against the butments is much greater, and tends much more to separate them, and to force them in the shore, but all these obstacles have been overcome with uncommon ability.

Foreseeing that by the successive improvements of the Thames, the bed of this river might become deeper under the Southwark bridge, Mr. Rennie directed that the first course of the piers should be laid nearly ten feet below its actual bed; this foundation rises like the steps of a pyramid, having thirty-six feet width at the base, and twenty-four feet at the point where the vertical part of the pier commences. It rests upon ten rows of piles.

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* At low water it is thirteen feet deep under the Southwark bridge, and eight feet under the Strand.

At high tides the lowest point where it was necessary to lay the first course of the foundation, was thirty-six feet beneath the level of the water; hence resulted an enormous pressure against the dam which surrounded the space reserved for the pier, and consequently great filtrations took place, in spite of the great care that had been taken in the construction of this dam; it had been formed by means of three rows of piles, representing three oblong octagons, one in another, the width of the inside one was sixty feet, the length nearly double that. The thickness of the dam did not exceed six feet.

The piles were from thirteen to fourteen inches square, and fifty feet in length—namely, fifteen feet eight inches sunk in the ground, from twenty-six to twenty-eight feet for high tides, and eight or six feet above high water. When the water allowed it, traverses were fixed inside the dam, having sixty feet in length, and pressing at each end against longitudinal timbers, which by this means supported the rows of piles against the pressure of the fluid. Within the dam, around the space left for the pier, a range of planks has been driven, from six inches to eight inches in width, joined close together, but without nails or grooves—they are intended to prevent that any small stream of water should make its way between the piles, and thus wash away part of the ground in which these piles are driven. The abutments on shore have their piles at the distance of three feet four inches from each other; they are covered with a strong frame of timber, planked over. Below the dams, sixteen or eighteen isolated piles were driven, as a defence against the crafts which navigated the river during the works. These piles, or stakes, and all those of the dams, have since been drawn up. At first the piles were driven at equal intervals, so as to form the figure of the three octagons. Afterwards other piles were driven with force in those intervals, so as to close them; and then were the three rows formed, and the space between them filled with gravelly earth. A steam engine, on the plan of Watt and Boulton, of fourteen-horse power, was placed on the left bank of the Thames, to give movement to the pistons of several pumps established within the dam; the alternate movement being transmitted by means of scaffoldings, reaching from the shore to the piles.

To build the abutments on the shore, a dam was constructed in front of them; they were drained, and afterwards the ground was prepared, to which was given a sloping direction of two on fifteen, towards the middle of the river—the piles of the abutments were driven perpendicularly to this inclination. On the wooden flooring supported by the piles, like that of the piers, they laid the first courses in Portland stones, each course being on a plane more and more inclined towards the middle of the river, and the stones being kept fast to one another by dice, which prevented their slipping towards the river, by the sole power of their weight; thus, the plane of the last or upper course was exactly perpendicular to the springing of the arch, and therefore more capable of resisting the pressure of the first rib. The total width of each abutment is eighty feet. A passage has been made through them; it is vaulted in a semi-circular form.

Structure of the Arches.—Each arch is composed of eight ribs; these ribs are all alike, and of the same dimensions; they are flat, vertical, and have a perpendicular direction towards the water. Each rib presents two distinct parts; the first is massive, and forms the lower contour of the centre; the second, which goes from the centre to the platform of the bridge, and which the French call *tympan*, is open.

The iron *voussoirs* are only two inches and three-quarters in thickness, thus, the eight ribs are equivalent to a massive centre of fourteen inches in thickness, which is not too much to sustain a bridge fifty feet and a half wide.

That which gives strength to the *voussoirs* is their having a rim nearly four inches high; by this means they present a greater surface of joints to bear a vertical pressure; and, above all, a much greater solidity to resist any lateral shock. Finally, the alteration which the *voussoirs* may undergo through the variations of temperature can have no other effect than to augment or diminish a little the curve of the arch; but it appears impossible that it could break masses of iron so large and so judiciously arranged. It must be observed that these *voussoirs* have their lateral joints much larger at the spring of the arch than at the key; thus the lowest, upon which all the others bear, is eight feet in width, whilst that which forms the key is only six feet. The *voussoirs* composing the same rib are not in immediate contact—in this, Mr. Rennie has disregarded the usual practice, in a way well worth your notice. Transversal plates of iron of the same breadth and thickness as the *voussoirs*, which they isolate from each other, traverse at right angles all the ribs; these plates are as many in number as there are joints between the *voussoirs* of each rib; there are, moreover, two of these plates at the junction of the lowest *voussoirs* with the piers or abutments which carry the arch.

Such is the ingenious structure of the *centre* which supports both the *tympan* and the bridge road. The *tympan* is composed, as we have already observed, of open ribs, resting vertically upon the solid ribs just described—the outside ribs of the *tympan* present the figures of lozenges, which diminish in size as they approach the key of the arch; these lozenges are contiguous with each other, and joined at the extremities of their smaller diagonals, which diagonals form altogether part of a polygon, or rather a segment of a circle, which divides into two equal parts the space comprised between the centre and the platform. As we have remarked, the lozenges diminish in size in approaching the key of the arch; the size of the iron pieces which form their sides diminish in the same proportion; the lower summits or point of the lozenges rest upon the centre, their upper summits support the bridge-road. The sides, nearly vertical, of the pieces composing the ribs, are joined with screw-bolts, passing through the rims raised on the outside, and which, in those places, are strengthened by a greater thickness, (*renforts quarrés.*) By this means there are two lozenges and four half-lozenges in each separate piece; the sides of these pieces are cast at once. The two pieces, next to the piers and abutments, present only one lozenge and two half ones; without this precaution they would have been too heavy, on account of their size, which would have rendered it difficult to move and place them, without running the danger of breaking them.

The lower summits of the lozenges are, as may be seen from the plate, connected together by an arc, which follows the contour of the extrados of the *voussoirs;* their upper summits are connected in the same manner by an arc following the contour of the bridge road; thus the space comprised between the road and the *voussoirs* is divided into four distinct series of triangles—the first have their base resting upon the *voussoirs;* the second and third have theirs above and below the intermediate arc which, as it has been observed, divides the *tympan;* the fourth have their bases under the contour of the bridge-road.

The part of the ribs upon which the bases of the first series of triangles are resting, is made to fit in a groove, in the extrados of the *voussoirs.* Screw-bolts run through the bases and the *voussoirs.* Besides this, the upper pieces are provided with dove-tails, which are received into spaces of similar form, hollowed out in the *voussoirs;* the space which is hollow, is larger than the part which it is to receive; but the vacuum is filled up by two iron wedges, which give to the whole assemblage a great firmness and solidity.

The upper side of the open ribs is joined with the timbers, placed length-ways in the bridge-road, by means of screw-bolts running through nuts made in the side of the rib, to give it additional strength*.

Weight of the materials of half the middle arch of the Southwark Bridge.

No.	Voussoirs.	Diagonals.	Traverses.	St. And. Cross.	Lozenges.	Tons.
1.	62.18	2.11	11.	9.10	26.4	112.3
2.	60.9	2.12	10.13	8.15	20.3	102.12
3.	54.15	2.13	10.2	8.2	32.16	108.08
4.	51.3	2.11	9.17	,,	24.5	87.16
5.	50.17	2.13	9.15	,,	32.14	95.19
6.	51.2	2.13	9.15	,,	24.15	88.05
7.	25.12	2.1	,,	,,	20.7	48.11
					Together . . .	643.11

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* Messrs. Walker, of Rotheram, cast the large and fine masses which support the arches of this bridge. The price of casting, transport, and putting up, was 18*l.* per ton. It was likewise at Rotheram, in Yorkshire, that the parts for the bridges of Sunderland on the Wear, of Yarmouth on the Tees, and of Staines on the Thames, were cast.

	Tons.
Plates that cover the bridge under the floor of the road	152.0
Cornices and paling	77.3
Road and pavement	650.
Plates resting upon the piers and on the half piers on shore	13.
Total weight of iron in the three arches . . .	5584.
Weight of a half pier	11000.

CHAPTER IV.

Suspension Bridges, Landing-Piers, and Aqueducts.

Europeans were preceded by Asiatics in the erection of suspension bridges, whether by cables of vegetable substances, or iron chains. In China, and in Thibet, the natives of the west have admired those bold constructions which embellish the narratives of their travels. Thus we have been told by them, that one of the largest works of this kind, the bridge of Chuka, thrown over the Jampoo, has existed from time immemorial. But in this species of works, as well as in several other branches of human industry, the eastern nations, after having, even in the earliest times, made astonishing progress, stopped all at once in their march. Thus, the inhabitants of Thibet and China erected such suspension bridges as would allow a man with a burden, or even beasts of burden, to pass the largest rivers; but they never conceived the idea of a bridge upon which horses drawing carriages could pass with security; this great step was reserved for the nations of Europe.

In a country where all the forms of nature seem proportioned to the grandeur of the continent which they characterize,—in North America*,—the inhabitants were compelled to throw bridges over the largest rivers known, and across precipices not less considerable; to obtain this end, they were under the necessity of finding some method easy and little expensive. Suspension bridges appeared to them to unite this double advantage; they therefore attempted to erect one sufficiently strong to carry horses and carriages; this bold attempt was crowned with complete success. Now may be seen, above the cataracts of Sckuylkill, a bridge suspended in the air, from three points of support only, and on a length of above 100 yards. Again, another bridge, supported by four points, and being 158 yards long, may be seen; and a third, in the state of Massachusetts, sustained by two points of support only, at a distance of eighty-one yards from each other, has been thrown over the Merrimack, which exceeds, by a great deal, the span of stone bridges, executed with all the perfection of which modern art is capable.

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* The same want was felt in the other parts of the continent

From North America, this noble application of art was soon transferred and naturalized in Europe *.

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to which this country belongs. Robertson tells us, in his History of America, that the Peruvians, forming very strong cables with twisted willow, stretched them across rivers, and joined them together, by interweaving them with small cords, sufficiently close to each other to form a compact tissue, which they used as a road. But these roads were bent like the cables, and consequently very inconvenient in their access.

* For a long time Europeans have had an idea of suspension bridges, as may be seen in the bridges described in the work that Faustus Verentius published in 1625.

It was just, that it should be first adopted on our continent, by the nation who had surpassed others in the execution of those great works, in which iron is the principal element.

Eighty years ago, the English threw over the Tees, at Winch, near Durham, a bridge of iron-wire, which served for foot-passengers. In the present century, by means of chains placed close to each other, carrying cross-beams and planks laid longitudinally, they have constructed bridges, over which workmen might pass with loaded wheel-barrows. Such were the bridges established on iron-chains, and thrown from one eminence to another, for the purpose of carrying away the earth which they had to remove, in order to disengage the blocks of marble which were then blown up with gun-powder, and employed afterwards to form the great Breakwater at Plymouth. These works, which I first made known on the continent, as well as the essays of Captain Brown, were executed in the south of England, as early as 1816, and even before. Towards the end of 1816, the Scotch introduced the use of suspension bridges into their country, but without extending them, at first, to the passage of horses and carriages. The constructions of this kind, due to Scottish engineers, have this in common, that iron wires are employed in lieu of cables of suspension; but they differ much as to the manner in which the floors are suspended.

To simplify the descriptions, we will call *suspen-*

soires, (suspending rods,) the pieces of iron employed for this suspension. There are bridges of which the suspending rods are directed obliquely from each support or point of suspension, to the platform of the floor. This last system, proposed by M. Poyet, in France, more than thirty years ago, is the least advantageous, and cannot be sufficient for bridges of large dimensions. The suspenders vertically directed from the cables of suspension to the floor, are, in every respect, preferable, as has been demonstrated by experience.

Mr. Stevenson*, a Scotch engineer, whom we have frequent occasion to quote, is the author of a project for suspension bridges, remarkable for the happy originality of many of its parts.

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* Mr. Stevenson, in an excellent account of suspension bridges in Scotland, mentions those which have been constructed since 1816. It was in that year that the bridge of Galashiel was erected for 40*l.* only, although the length was equal to 112 feet; it is suspended from iron wires of very small diameter.

The King's Meadow bridge was constructed in 1816, on the Tweed, near Peebles, for the sum of 160*l.* Its length is 110 feet, and its breadth four feet. Tubes of cast-iron (*a*) buried in the soil, separated from one another by a space equal to the width of the bridge, serve to support the suspending wires, about three-tenths of an inch in diameter. The suspending wires of the flooring, which are oblique, instead of being vertical, are five in number, and attached to an iron bar (*b*) inserted vertically in each tube. The road-way is formed with frames of wrought iron, covered over with deal boards, six inches in width, and one inch and a half thick. On each side of the bridge, chains serving as braces (c) are fixed by one end, into a masonry laid under ground, and by

(*a*) Height of the tubes, nine feet; thickness, three-quarters of an inch.

(*b*) Height of the bars ten feet; their square two inches and a half.

(*c*) Diameter of the iron braces or wards, three-quarters of an inch; length of the links, five feet.

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the other, on the iron bars inserted in the tubes. Finally, numerous screw-bolts serve to tighten and set up the suspension-wires the road-way and the braces.

Dryburgh bridges; they are thrown eighteen feet above the surface of the low water of a torrent, between two supports at 260 feet distance from each other. Notwithstanding this great extent, the first bridge, erected in 1817, was supported by oblique or diagonal suspension-chains. When people passsed it, the mere act of walking produced considerable vibrations. During the winter of 1818, a very high wind, which gave to the road-way a strong undulating motion, at last tore it away, after having broken the suspension-chains.

A new bridge was built; perpendicular suspending-rods (*a*) were added, as well as under-chains going from one abutment to the other, under the beams of the road-way (*b*). On each side, a diagonal trellis, firmly joined, forms a parapet. It prevents the bridge experiencing those vertical undulations like those of the sea, and which had so much contributed to the rupture of the first bridge. These various additions made the expenses amount to 720*l.*, which had only amounted to 500*l.* in the erection of the first.

Two suspension-chains (*c*) are established on each side of the bridge, in a horizontal position relatively to each other, and touch, in the middle, the top of the parapet; they are fastened upon the head of the wooden vertical pillars (*d*). The two pillars, placed

(*a*) The perpendicular suspending-rods are half an inch in diameter. They have at the top, a cross head, by which they are kept between the oval links of the suspension-chain. At the lower end they pass through the side-beams of the flooring, under which they are screwed.

(*b*) These chains are nearly one inch in diameter.

(*c*) The suspension-chains are one inch and five-twelfths in diameter. The length of the bars composing them is ten feet. There is an eye at each extremity of the bar. An oval ring, nine inches in length, passes through the eyes of two contiguous bars.

(*d*) These pillars are twenty-eight feet above the level of the roadway. The space between them, forming the approach to the bridge, is nine feet.

In this plan, the suspension-chains, which it would be better to call supporting-chains, are under the flooring; they support it by means of vertical rods of cast iron, kept in their respective distances by small arches of the same metal, placed in a horizontal line under the flooring. This flooring is composed of a platform of cast iron, upon which is laid a layer of stones, broken small, to prevent the pernicious effects of the vibrations of a wooden platform. The chains pass over each abutment, descend behind it, and terminate in the masonry, in a place at all times accessible, by means of a subterraneous passage. The lower extremity of the chains has a head which rests against the base of a conical tube of cast iron through which the chain passes. This tube, strongly imbedded in the masonry, keeps the chain perfectly secure. Mr. Stevenson thinks, that bridges, not exceeding 200 feet in space, should alone be executed upon this system.

The Americans commenced their constructions about the end of the last century. As early as 1813, Mr. Telford proposed to construct a bridge of suspension over the Mersey, at the place where the Duke of Bridgewater's canal communicates with that river; a situation, as the reader will see, well

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at each extremity of the bridge, are connected by braces forming a *croix de Saint André*, and by transom-beams upon which the suspension-chains rest. Each pair of chains are at twelve feet distance from each other, when passing over the pillars, and only at four feet and a half towards the middle of the bridge. They have, therefore, by means of the suspending rods, an oblique power, both in the horizontal and vertical directions; a circumstance which must prevent the bridge from having an horizontal oscillatory motion.

The structure of the flooring is simple; two fir beams are connected to each other with cross-pieces of timber mortised into them, which carry boards, between which small openings are left to let off the moisture in bad weather.

adapted for the outlet of a great commerce. This bridge was to have only four supports, and to be composed of three arches, having respectively 500 feet, 1000 feet, and 500 feet in span; making a total length of 2000 feet. The size, and I may say the audacity, of this project, frightened the capitalists to whom it was proposed; but it had, at least, the advantage of drawing public attention to this new species of constructions. It caused a number of experiments to be made on the strength of iron, and on its utility when employed for suspension bridges. These experiments have been published by Mr. Barlow, professor of mathematics at the military college at Woolwich, in the useful treatise written by this learned man, on the strength of wood and iron.

In 1818, Mr. Telford, to whom had been intrusted the construction of the road leading from London to Ireland, through Wales, had presented the plan of a suspension-bridge, to cross the arm of the sea which separates England from the Isle of Anglesea, called the Menai Straits. This time, his plan was accepted. Its execution is far advanced, but as yet nothing has been done concerning the suspension part, properly speaking.

Captain Brown has the honour of having erected, in Great Britain, the first bridge of suspension for heavy vehicles. By persevering experiments, during the space of ten years, in order to employ iron instead of ropes in the making of the ships' standing rigging,—to substitute iron chains on board vessels for hemp cables, Captain Brown must necessarily have acquired a great experience on the strength of these chains; being besides as ingenious as persevering, he re-united, in his own person, all that could promise a fortunate issue to his undertaking. He began by constructing, in his own iron-cable manufactory, at the Isle of Dogs, near London, the model of an arch of 100 feet in span. I have myself gone over it in a carriage, with its able constructor, before he applied this invention to still bolder works. This first trial having proved satisfactory, it served him to regulate the proportions of the iron parts of the bridge which he was about to suspend over the Tweed, near Kelso,—an enterprise which he executed, with complete success, in less than one year, (from August 1819, to July 1820).—*See plate.* This bridge unites lightness with solidity; several vehicles may pass it at the same time without its structure being endangered by it. The oscillations are very inconsiderable, and the vibrations, although perceivable, produce no inconvenience. It is 300 feet in length, by eighteen feet in width; it has a carriage-road in the middle.

The masonry of the two high piers, which serve to support the chains of suspension, as well as all the iron and timber employed in this great work, cost only 5000*l.* But, since the completion of this monument of public utility, the company to whom it belongs made Captain Brown a present of 1000 guineas—a present richly merited; for this generous inventor, who was actuated solely by a desire to exhibit a fine and grand example of his new constructions, had only demanded a sum adequate to cover his expenses, thus making a sacrifice of the just compensation due to his invention and exertions.

We will now describe minutely the structure of this suspension bridge. The road-way is twenty-seven feet above the level of the low water in summer. Instead of being on a level horizontal line, the road presents a gentle rise towards the middle, which is two feet higher than the extremities. If, by the effect of the heavy burdens carried upon the bridge, the chains and suspending rods should be lengthened a little, the flooring, in sinking, will only approach more and more to a level line.

There are twelve suspension-chains, arranged in pairs, and disposed as in fig. 1, (see plate.) These chains, and all the other iron works were cast or wrought in Wales, at the manufactory of Samuel Brown and Co., where they make chain cables with a very soft and tenacious iron, such as suspension bridges require.

The diameter of the iron of the chains is two inches; the links are composed of bars fifteen feet long, terminated with an eye at each end. (See plate, fig. A. B. C.) Two short flat links are applied on each side of the two contiguous bars; and bolts, well riveted, traverse respectively the two links as well as the eye of a bar.

In figure A may be seen a vertical suspending-rod; it has one inch in diameter; it passes through a sort of cap, which Captain Brown calls a saddle-piece; the bolts are cylindrical, having for their base an ellipsis, of which both axes are respectively two inches, and 2$\frac{4}{6}$ inches.

The disposition of the three chains, which are almost in a perpendicular direction with each other, is such, that the equidistant suspending-rods are fastened to the chains in the following order—first, to the upper; secondly, to the middle; thirdly, to the lower. The chains which correspond with each other, right and left of the bridge, have their joints so placed that the suspending-rods correspond likewise perfectly; thus, in a plan parallel to the length of the bridge, such as fig. 1, the suspenders and the chains are four and four, represented in a vertical projection, by the same lines.

It follows, from this, that four suspending-rods serve to suspend each of the beams of the roadway *.

The disposition here described has great advantages. When one or several considerable weights pass over the bridge, the floor, by its flexibility, must alter its form, in proportion as the weight advances; it must yield more or less under it, and rise in the intermediate part, on the side of each abutment. These light movements take place without injuring the solidity of the whole edifice, because the only alteration it occasions in the appearance of the bridge, is in the angles of the polygon, formed by the bars which compose each of the suspension-chains. All the parts yield in proportion to the power which acts upon them, but without sustaining a distortion capable of endangering the whole system.

The lower end of the suspending-rods traverses a longitudinal piece of iron, on the extremity of which the beams of the floor rest, and under which the rod is riveted with a very strong pin. These beams are fifteen inches thick vertically, and seven inches wide. They are covered over with jointed planks one foot wide, by $3\frac{8}{12}$ inches thick, fig. F.

In place of a parapet, Captain Brown has adopted an iron railing, the lozenges of which are six inches a side. In order to render the passage of this bridge perfectly secure to foot-passengers and horsemen, this railing is five feet high.

We will now return to the chains; their length is necessarily more considerable between the points of support than the span of the bridge, between the abutments. The distance between the points of support is 437 feet, although the distance between the abutments is only 360 feet. The angle formed by the direction of the chains with the vertical line, from the points of suspension, is equal to seventy-eight degrees. The weight of each chain with

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* The longitudinal distance of the consecutive bars belonging to different chains is only five feet; that of the bars proceeding from the same chain is fifteen feet.

the suspending rods, the bolts, links, &c., is about 900lbs. The twelve chains and all the iron in the bridge weighs 13,000lbs.

One of the most advantageous things in Captain Brown's system is, that all the parts of the chains of the suspension, suspending rods, and the flooring, may be undone separately, or changed, if occasion require, without scaffolding, or interrupting the passage of carriages or foot-passengers. Fig. V. represents, in half length, the apparatus used to change a bar in a chain of suspension. Fig. 6 represents some details about the joining of the pieces together, as explained in Captain Brown's patent.

We have now to explain the system of masonry employed to sustain the bridge; it is the work of Mr. J. Rennie. On the English side, the pier that supports the chains is backed against the steep rock which borders the river, and rests upon it; it is not much more than twenty feet high; its other dimensions are the same as those of the isolated pier *. On the other side the road passes through the latter †, but it turns off, to follow a course parallel to the river, in front of the first.

The pairs of chains run in the masonry of the piers, through openings which are two feet, one above another. They run on rollers ‡, the axle-trees of which rest on masses of iron, imbedded in the masonry. In this part, all the chains, instead of being formed with bars, fifteen feet long, are composed of very short

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* The isolated pier is sixty feet high. Its form is that of an Egyptian Pylon, that is to say, a vast trunk of a pyramid; it is seventeen feet and a half in thickness, measured in the longitudinal direction of the bridge; it is thirty-six feet wide at half its height; in its lower part, or sub-basement, the pier is square, to a height of about ten feet; above this it slopes off about a twelfth part.

† The arched gate-way under this pier is twelve feet wide and seventeen feet high.

‡ On the pier, which is on the English side, instead of rollers, plates of cast iron are imbedded in the masonry.

links, similar to those of the chain of a watch; this form permits them to run over the rollers smoothly and without being distorted.

One of the most difficult things in the building of suspension bridges, is the fixing the extremity of the chains on the final points of support. The strain on the chains being very considerable, it is necessary to find means capable of resisting the most powerful efforts. After going through the masonry of the pier, each chain descends to the ground: in this last part, the chain is again formed of long bars, joined by bolts and double links, like that on which the bridge is suspended; they go twenty-four feet under ground; there they pass through enormous masses of cast iron*, of a square form, under which they are held by strong iron bolts of an oval form; these masses of iron are loaded with stone and earth, up to the level of the road. Thus to make the chains give way, the stones and earth resting upon these metallic masses, to a depth of twenty-four feet, must be torn from the ground around them; a thing utterly impossible.

On the English side, the large masses of iron, serving to hold fast the ends of the chains, instead of being buried in the ground, as on the Scottish side, are above the level of the foundations of the pier. They are in a situation nearly vertical, which corresponds with the strain of the chains. A horizontal arch, the stones of which are imbedded into the rock, serves to keep the iron plates in their proper position.

After Captain Brown and Mr. Telford, Mr. Brunel is the next who constructed suspension bridges. He has disposed the parts with that equal [illegible]ss of ingenuity and perfection which characterizes all his works. In 1823 he had cast, at Sheffield, the iron pieces designed for two bridges in the Isle of Bourbon. It was necessary that both should be sufficiently powerful to resist the storms which tear up trees by the roots, and swallow up vessels, by gusts of wind, which act with extraordinary force, not only in a horizontal but in a vertical direction, and, by turns, upwards and downwards. Mr. Brunel obtained a proper resistance (see plate) by employing a double system of chains —first, the usual upper chains; secondly, lower and inverted chains, united to the road-way of the bridge by vertical rods, which are, properly speaking, the suspending bars of the inverted chains. In order to give firmness to the road of the bridge, horizontally with the stream, the lower chains, instead of being on a parallel plane with the upper ones, diverge from them near the points of support, as is clearly shewn in fig. 2.

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* These masses are six feet long and five feet wide; they are differen[illegible]es thick in the middle, and only two inches and a half on the sa[illegible]s.

This bridge, of which we give the plan, has two arches; the other has only one, equal in span to the two of the first; the latter bridge must be considered, as to the structure, as a simplification of the first, without any material alterations.

To describe this bridge with order, we shall notice, first, the pier and bench which surmount it. Secondly, the abutments and benches which surmount them. Thirdly, the form of, and mode of attaching, the chains of suspension, and of the inverted ones. Fourthly, the road-way and suspending rods. We will first remark, that the horizontal distance measured from the middle of the two arches bridge to the support of each abutment, is 132 feet; the span of each arch, between the middle pier and the abutments, is 122 feet.

1st. *Of the Pier and the bench on its summit.*—Fig. C. represents in full the plan of the pier, for half its length, and the base of the bench which it carries. The elevation of the same pier is sufficiently detailed in fig. 1. The longitudinal elevation, and half the transversal elevation of the bench are represented in full by the figs. A, B. This bench is formed, in the middle and on each side of the bridge, of two oblique pieces, wider apart at the foot; the pieces at the sides are connected with those of the middle; first, at top, by a single traverse; secondly, about the middles, by two transverse pieces, above which are St. Andrew's crosses, formed by diagonal braces of wrought iron. The crosses consolidate the upper part of the system, without interfering at all with the double gate-way below, reserved for the passage of carriages and foot-passengers. The construction of this bench is an excellent combination of braces of wrought iron, and supports of cast iron, which have the advantage of uniting economy, lightness, and solidity.

2nd. *Of the Abutments and their benches.*—The masonry of each of these includes,—a subterraneous passage which is traversed by the inverted chains—and a narrow arch, through which the suspension chain passes, and at the foot of which is its point of support. (See fig. 1.) Above each pier is a small bench of cast iron, composed of two vertical posts, or muntins, two diagonal supports, an open frame* resting on the pier, and a horizontal traverse which connects the tops of the two posts.

3d. *Of the form and mode of attaching the chains of suspension*

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* Solid bolts unite the sides of the frame-work with the masonry, which they penetrate to a great depth.

and the inverted chains. The chains of suspension have their respective points of support at 24 feet $\frac{8}{12}$ above the masonry of the middle pier, and at five feet above that of the abutments.

The chains pass right and left of the suspending rods in the middle and on the sides of the bridge; there are, therefore, six pairs of suspension chains: they are composed, first, of a series of long links, having their sides parallel to each other, standing vertically, and rounded at each extremity; these links are almost in contact with each other. 2nd. Of short links of similar form, placed right and left, at each extremity of the long links, so that a bolt traverses at the same time, the demi-circular end of a large, and of two small links[*]. But, moreover, each bolt serves at once for the two suspension chains of each pair. One of these bolts passes likewise through the eye of a suspension rod, of which it is thus the upper support[†]. There is one rod to every long link.

Towards the benches, and at every fourth link, the bolts are made of three pieces; two demi-circular ones, and the third flat, in the shape of a wedge. By means of this wedge, which may be replaced by another, either thicker or smaller, the suspension chain may be lengthened or shortened when necessary.

In the plan of fig. 1. are seen a horizontal line, and joints in the middle of the suspending rods; it is an iron bar, passing through the four first rods of each arch; it runs through a ring, which itself passes through the eyes of each of the two parts of which these rods are composed.

The structure of the inverted chains is not the same as that of the chains of suspension. These last are formed of long links, which present in reality two ranges of iron bars; the others have only a single range *, having a circular eye at each extremity, and joined end to end between plates having three holes pierced in them. (See fig. H. and H.H.)

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[*] The iron of the long links is round; its diameter is 1$\frac{2}{8}$ inches, the links are 41$\frac{6}{12}$ feet long; the iron of the short links is square; it is 1$\frac{2}{3}$ inches square; the diameter of the bolts is two inches.

[†] The distance between the points where the suspending rods are attached, measured on the chains, is five feet.

Fig. K. shews the manner in which two bars of the inverted chains and one of the lower suspension rods are joined together †. From this figure it will be seen that two flat links pierced with three holes, to receive three bolts, belong respectively to two contiguous bars of the inverted chain, and to the lower rod between them. The upper part of this suspending rod goes through the corresponding beam, close to one of the upper rods, and is fastened by a screw on its head. The last bar of the inverted chain, towards the middle of the river, is double, and goes through the whole thickness of the masonry of the pier, and in coming out it is set in a large plate of cast iron; thus a great part of the pier has to support the great strain or tensions which the inverted chains must experience during storms, and when the wind blows upwards. The same system is used to attach the other extremity of the inverted chains on the abutments.

One of the most ingenious dispositions in this is, I think, the suspension of the chains on the top of the great bench, on the pier of the bridge. Let us suppose, fig. 6, small swinging frames of iron, having the form of a rectangle, two sides of which are vertical, and two horizontal. There is one frame or rectangle to each chain; the upper horizontal side, which is as the pivot upon which the frame swings, is fixed at both ends into a jointing at the summit of the bench, in the plan of a chain of suspension, and the lower horizontal side serves at once as a support and a bolt ‡ to the two highest links of the suspension and the ward chains.

By this disposition, when burdens pass on one part of the bridge,

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* Diameter of these bars one inch $\frac{3}{12}$.

† The lower suspension rods are one inch $\frac{1}{12}$ in diameter.

‡ The diameter of the side acting as a pivot, and of the other acting as a bolt, is two inches and a half.

and occasion the suspension chains to give way more towards one end than the other, either towards the pier or towards the abutments, the little possible oscillation of the rectangles, on which the chains are suspended, causes them to yield slightly to the efforts produced by the movement of the burden; this ingenious means prevents also all tendency to rupture, which would necessarily result from shocks exercised upon a system offering a rigid resistance.

4thly. *Of the Road-way and Suspending Rods.*—Fig. E. represents, for half the breadth of the bridge, on the left of the pier, the plan of a portion of the road-way, perfect and seen from above; and, on the right, the plan of the frame-work which supports the platform of the road-way. It is furnished with plates * and wheel tracks of iron, which offer a road, as easy as durable, for the carriages which pass over it †. Iron strips, or laths ‡, are laid down transversely, with small intervals between them, to give the feet of the horses a firmer hold.

Fig. D. exhibits the foot-pavements, as well as the two carriage roads. They are separated by a row of suspending rods, and by two chains of suspension. This figure shows us also longitudinally, in elevation, the transversal beams Z. Z. which support the long planks forming the flooring. These beams are of cast iron, wide vertically, narrow horizontally, rising towards the middle, and strengthened by a rim in the whole length of their base.

The transversal beams occupy but half of the width of the bridge, and are joined together, end to end, by two screw bolts. The joints of the ends of these beams is crossed by one of the middle suspending rods, the lower extremity of which goes also through a strong circular die. This die, which supports the two contiguous ends of the beams, is fastened under them by means of a nut, at the end of the suspending rod; this joining is simple and firm. The outside end of the beams presents a circular vertical hole, through which one of the outside rods passes; this rod is likewise fastened under the beam by a nut.

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* The flat bands are one-third of an inch thick; the wheel tracks two-thirds; the latter are turned up at right angles.

† The carriages which they employ in the isle of Bourbon are small, narrow, and do not weigh more than 2200lbs.

‡ The thickness of the laths is a quarter of an inch.

Upon the whole length of the bridge, are placed upon the end of the iron cross-beams, three files of strong timbers*, one in the middle of the flooring, and one on each side. These longitudinal pieces are kept in their places by the suspending rods which traverse them, and by screw-bolts. These bolts have their heads resting on an iron plate, which covers, in this place only, the upper part of these longitudinal timbers.

The iron cross-beams carry a flooring of planks†, one inch $\frac{1}{6}$ thick, under the foot pavement, two inches, under the horse-road, and four inches, under the wheel-tracks, which are composed of long plates of cast iron.

The parapet is a grating formed of iron bars, or muntins, vertical and equidistant, placed close to the suspending rods, having $\frac{9}{12}$ of an inch in diameter. They are fixed, below, in a hole in the cap of cast iron with which the longitudinal timber is covered, at the place where it is traversed by the suspending rod. A double collar joins the top of these bars with the rods. Such are the principal upright bars which are connected together by an iron rail, fitted upon their upper extremity. The flooring of the bridge rises four feet $\frac{3}{12}$, from the abutments to the middle pier.

Chain Suspension Piers.

It is to Captain Brown again that the navy are indebted for the idea and execution of suspension chain piers, of a considerable length, in ports where ships are unable to approach the shore for a great distance. The navy and army will derive important advantages from these piers, in rapidly embarking troops and baggage, or disembarking the same.

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* They are eight inches square, their upper surface is in shape of a ridge or ass's back (dos d'âne.)

† The beams and planks are made of teak, a very strong and durable wood.

It was in the summer of 1821, that Captain Brown exhibited the first model of these new constructions, at Leith. The plates represent the longitudinal elevation of this pier, its plan, and a transversal elevation of its principal extremity, where the embarking and landing take place. The commodious, rapid, and certain use of steam-vessels had already increased much the arrivals and departures of passengers, and the transport of merchandise in the Forth, where the port of Leith is situated. It was essential to facilitate, by every possible means, the embarking and landing of passengers and goods. This motive determined the commanders of the steam-vessels, which navigated the gulf, to join other capitalists, and undertake, under a grant, the pier which we are about to describe.

In order to reach, from the shore, the place in the Forth, where ships could keep afloat without danger, at high or low water, and in very bad weather, it was necessary to advance 233 yards into the sea, reckoning the distance from the highwater-mark on shore. To fill up this long space, three arches of suspension chains were formed, each having 209 feet in span; thus the pier is held by four supports only—one on shore, and three upon piles in the middle of the sea. To describe this work systematically, we will mention, in succession, the piers, the abutments, the suspension chains, and the flooring or road-way.

Piers and Abutments.—The principal pier is that which is at the head of the Chain Pier; it is formed by six rows of piles* having the same direction with the suspension chains; cross timbers consolidate the part above water, the summit of which bears a flooring or platform of wood. This platform† has a hatch-way leading to a flight of stairs descending as low as the level of low water. A plank thrown across, from the last step to the steam-boats or other vessels near the landing pier, enables people either to land or to embark. The two intermediate piers, between the shore and the landing-place, are formed with piles, so planted as to represent a lozenge; they are covered over with a platform, upon which rests the iron bench which bears the suspension chains. To serve as a common support to these chains and their wards, a stone pillar has been built upon the shore, having twenty feet in height, upon a square base, six feet on each side; from the top of this pillar, or support, the chains, or land-wards, with an inclination of about forty-five degrees, reach the ground, in which they penetrate to a depth of about ten feet, where they are fixed by means of cast-iron ballast plates, in the same manner as has been described in speaking of the suspension bridge, thrown on the Tweed, under Captain Brown's direction.

On the side of the landing platform, each of the chains has likewise an inclination of forty-five degrees, and is attached to one of the piles supporting it. Shores, placed obliquely, serve the purpose of resisting the great strains experienced by the chains.

The figs. H. K. represent the benches used to support the chains; they are seen longitudinally and transversely; they are made of iron, open, but combining, nevertheless, lightness with solidity. At the summit of fig. H is seen the manner in which are attached two oblique suspending rods * supporting both the landing-pier and the flooring. Figs. F. G. show the way in which the bars composing these oblique suspending rods are joined. The muntens, of which fig. K. shows a half, are cast of one piece, and joined together with screw-bolts. On the right, at the top of fig. K., is seen a groove, adapted to receive the suspension chains.

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* There are forty-six piles driven about eight feet in the soil, which is composed of a thick clay.

† It is sixty feet long by fifty feet wide.

These chains, as to their form and the joining together of the parts composing them, resemble those used in the construction of the Union Bridge upon the Tweed; they differ in one point only; the links, which are close to the points of support, having to bear a greater strain, are made thicker than those placed in the middle of the chains †.

The suspending rods are round, except the lower end, where they fork, in order to receive the flat iron, or lath, which runs along the whole length of the chain pier, and upon which the end of the beams supporting the flooring are resting; the planks forming this flooring are two inches thick. On each side of the pier is a cornice which covers over the ends of the beams. The parapet is made of iron, four feet high, and firmly joined with the suspending rods.

In order to try the power of this chain pier, Captain Brown, as soon it was terminated, loaded it with the immense weight of 210 tons, which he suffered to remain for a great length of time, notwithstanding the casual burden occasioned by passengers, and the shaking produced by their movement. No part of the erection has been observed to suffer

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* They are one inch in diameter.

† The diameter is one inch and one-third; the diameter of the shackles which join them is two inches.

from these movements, or from the great strain produced on the chains by so great a burden. Such a fact affords the most satisfactory proof as to the solidity of this system of chain landing piers.

The Brighton Pier.—We suppose that, at the moment we write these pages, its construction is completed; its dimensions are on a much larger scale than those of the Leith pier. It is composed of three inverted arches, having each 230 feet in span; its width is twelve feet.

Chain suspension bridges must be particularly advantageous in hilly countries, where the expense attending the construction of stone bridges would, by far, exceed the advantages one might expect to derive from them. In those *departments* of France, where the mountains and hills have a steep and abrupt declivity, and where they are separated by narrow valleys; these valleys, as well as the precipices and beds of large torrents, may be crossed by the means of suspension bridges; they are durable, though light, and their construction combines solidity with economy; then the husbandman, cattle, beasts of burden, sportsmen, will no longer have to take a long circuit, often attended with danger. The wants of trade and agriculture will be easily and quickly supplied in those parts which now present numberless local obstacles.

The advantage of suspension bridges, compared with stone ones, is strikingly greater, when a rapid stream, with high banks, is to be crossed. In building the former, we do away with the necessity of erecting, in the very bed of the river, expensive piers, which are not only attended with great difficulties in their construction and the excavations often to be made, but which are afterwards dangerous to navigation, which they obstruct. Thus, for instance, if upon a certain point of a river 320 yards broad, we wished to erect a commmon stone bridge, we should have to construct at least six or eight piers, when, in building a suspension bridge it will be sufficient to attach, on the rocks, on the two opposite shores, the iron chains, which will form a single arch, without encumbering at all the water way.

In describing the chain pier constructed at Leith, under the direction of Captain Brown, we have endeavoured to point out the facility and economy resulting from such erections, with regard to the embarking and landing of sea passengers. It appears that the construction of chain or wire suspension bridges over the entrance of our military or merchant sea-ports would be no less advantageous. It would only be necessary to place those bridges at such a height as to allow vessels to pass under, without being obliged to lower their topmasts.

Suspension Aqueducts and Canals.—When it is intended to convey waters across narrow and deep valleys, instead of those aqueducts, supported by lofty arches, so expensive in their construction, it will be most economical to have recourse to suspension aqueducts, which may be composed of wooden or iron pipes. And, in the same manner as, over those stone arches, iron aqueducts have been laid, sufficiently large to admit boats, similar aqueducts may be suspended upon chains across deep valleys, and present as much security as economy.

France possesses already a small aqueduct, formed of one single pipe, carried by a suspension chain; it is erected on the Volvic estate, which belongs to M. de Chabrol, *Préfet de la Seine.* M. Navier, a civil engineer, after having visited England twice, for the purpose of examining suspension bridges, has written on the subject an excellent essay, in which he proposes the erection of suspension aqueducts, adapted to inland navigation. In this memorial he gives also the plan of a suspension bridge, which without any intermediate piers would cross the Seine, between the *Champs Elysées* and the *Invalides.*

MM. Seguin d'Annonay have been the first to erect suspension bridges in France. They have contented themselves with using wires instead of chains, which circumstance has rendered their constructions much less expensive. Thus, the bridge constructed for the passage of the workmen employed at Annonay, though fifty-two feet long, has only cost them *two pounds!!* These gentlemen have just obtained, from government, a grant for the construction of a suspension bridge 616 feet in length, intended to carry carriages. It will join Tain and Tournon, two towns built upon the opposite banks of the Rhone. The disinterested patriotism displayed, in this case, by the *directeur général* and the members of the council of the bridges and highways deserves the greatest praise. In thus encouraging and approving plans so advantageous to France, but which did not originate with the engineers whose works they inspect and order, they have not consulted their *Esprit de corps*, but the general good.

The inhabitants of Geneva have been the first to follow the means of execution adopted by MM. Seguin, in the erection of similar works; and M. Auguste Picket first communicated a description of these means to the *Bibliothèque Universelle*.—Colonel Dufour has undertaken to direct the construction of a bridge, suspended on iron wires, over the *fossés* of the town of Geneva.

END OF THE FIRST VOLUME.

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